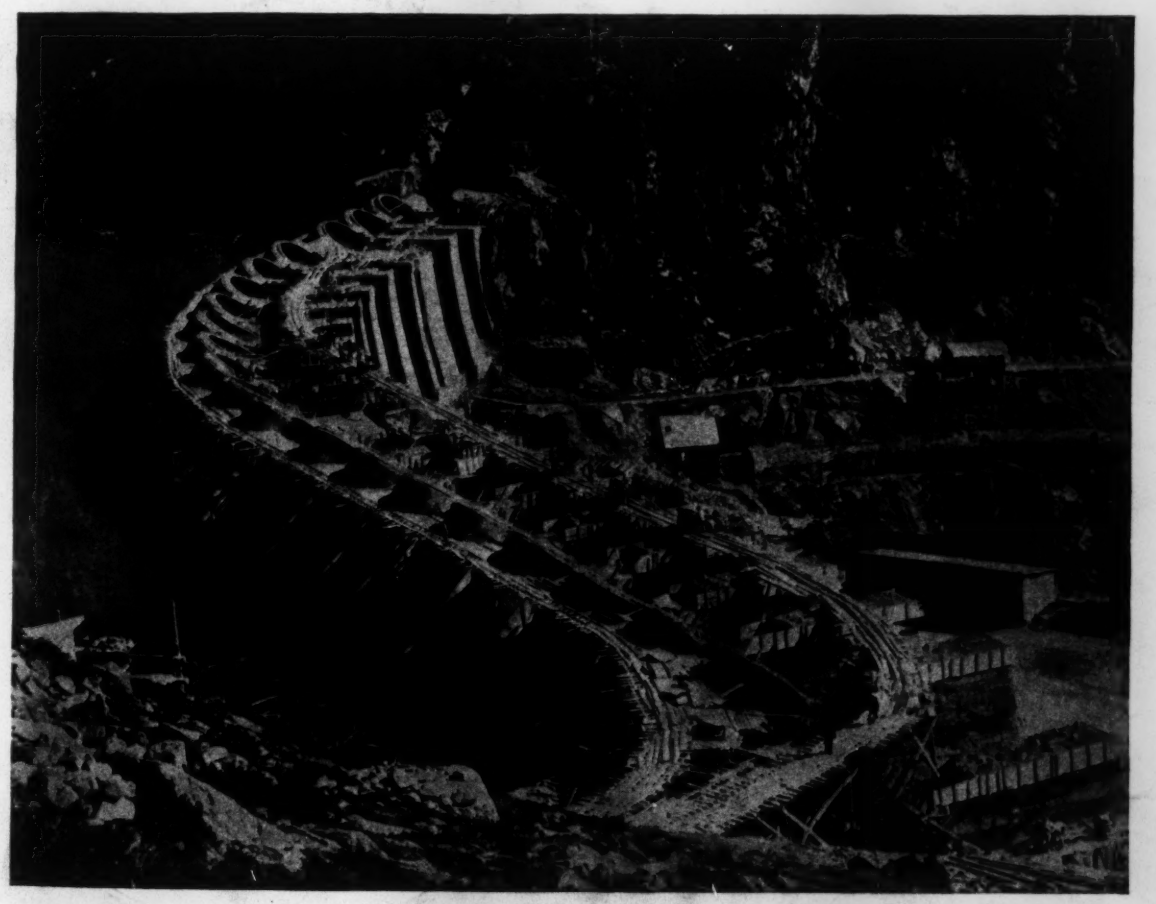
FEB 4 1924

Devoted to Civil Engineering and Contracting. McGraw-Hill Company, Inc.

January 31. 1924

Engineering News-Record

Progress on St. Paul's union station—Hygienic aspects of use of sewage sludge for fertilizer—Reinforcement checks cracking of concrete pavements—Failure of multiple-arch dam in Italy—Staff report on convention of Associated General Contractors



Construction View of Gleno Dam, Italy, Which Failed Last December

KREOLITE WOOD BLOCK FLOORS

Outlast the Factory

SMOOTH — WITHSTANDS HEAVY TRUCKING

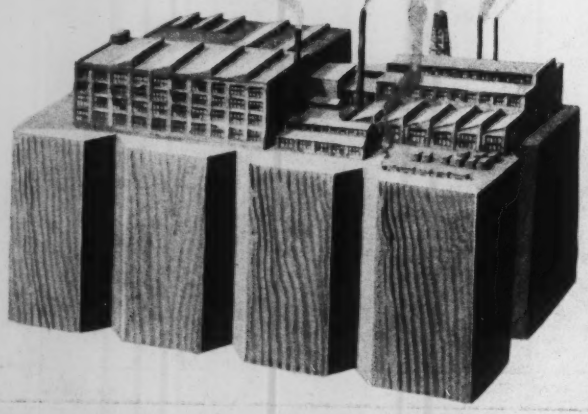
AUTOMOTIVE - LOW MAINTENENCE COST

INSTALLED WITHOUT INTERFERING WITH PRODUCTION

SANITARY - EASY TO KEEP CLEAN

COMFORTABLE FOR WORKMEN

ECONOMICAL DURABLE -



Big Business is Built On Kreolite Floors

As the *soil* is the producing part of a farm, so the *floor* is the producing surface of every factory.

Kreolite Floors are laid with the tough end grain uppermost. Once down, your flooring problems are *permanently at an end.*

These blocks, protected from decay and wear, are the foundation of successful production in *all* lines of business: machine shops, foundries, warehouses, bakeries, paper mills, tanneries, roundhouses, stables, etc.

Groaning loads simply compress the wood fibre, making the blocks *tougher* and *stronger.*

Through the Patented Grooves, the Kreolite Filler binds the blocks together into a unit of strength, making a floor that is warm, resilient and easy on workmen's feet. Wear—tear—heat—cold—moisture—acids—no matter what the need in *your* factory, Kreolite Floors *meet* it.

You can resurface old or worn floors with Kreolite Blocks without interfering with production.

Let our Kreolite factory engineers study your factory floor needs, *gratis.* Write for booklet.

KREOLITE REDWOOD FLOORS

California's famous Redwood Trees supply the material for Kreolite Redwood Block Floors. Under the Kreolite Process of Manufacture and Installation these Floors offer a polished smoothness that is especially adapted to the textile and other industrial lines requiring utmost cleanliness. Kreolite Redwood Floors are odorless, durable and fire-resistant—they radiate comfort and warmth. They are also suitable for department stores, hospitals, armories, schools, store rooms, office buildings, etc.

The Jennison-Wright Company
79 Kreolite Building
Toledo, Ohio

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

McGraw-Hill Company Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 92 NEW YORK, JANUARY 31, 1924 Number 5

An Unnecessary Committee?

IN THE news pages of this issue there is reproduced verbatim the statement of the Department of Commerce in appointing a committee of two engineers, a contractor, an architect and a cement man "to survey the uses and properties of cement and concrete." This is a strange and vague statement, quite mysterious to those whose business it is to design and build concrete structures. There are no great dissonances in the concrete orchestra that can be harmonized by the paternal wand of a government committee; there are no great number of disjointed theories or experiments that need co-relating. Just what is it intended that the committee should do, except to put the seal of official approval on work already done and well known to the profession and industry? There is one thing such a committee might do, but the statement gives little indication or hope that it will be done. The Bureau of Standards is the best equipped institution in the United States to study the nature of cement—a subject of exceedingly great interest just now. But the Bureau has little money. If the committee really wants to add something of value to our knowledge let it exert itself to persuade Congress to give the Bureau some funds to make a study of cements. Seasonal employment, improved concrete appliances and the co-ordination of test results are being taken care of well enough elsewhere.

A. G. C. Records Progress

THE alertness of the organized contractors to the large problems which confront the construction industry was perhaps the leading impression taken home from the convention last week in Chicago of the Associated General Contractors of America. Very little of the convention time was consumed in considering the minutiæ of methods or individual practices. There was instead full discussion of labor supply including the vital questions of training apprentices, reducing seasonal employment, advancing safety conditions and wisely directing immigration. Definite action was taken to improve contract surety bonding practice and to advance simplification of contract-forms and of equipment and materials. Support was extended to action for a federal department of public works, a federal contract law and to the plan of the Treasury Department for tax reform. It was urged that the railways be given a chance, without further legislation, to develop and prove the merits of the present plan under which they are operating. All these are vital questions in the industrial world and the action taken on them was not merely perfunctory, it was in the nature of instruction to an executive staff and working committees to drive their efforts to the limit of the influence of the contracting business. Its assumption of a position in the creative work of the construction industry and the recognition by the industry of its power and energy as a constructive force are the great advances which the Associated General Contractors have made in the last year and they were clearly expressed by the character of the work of the Chicago convention.

Belated Vindications

"THE evil that men do lives after them; the good is oft interred with their bones." The men who were indicted and sued by a political Department of Justice for so-called war frauds have been branded by the public. As they are acquitted one by one few see the obscure accounts of such acquittals, the news value of which the daily papers apparently consider negligible. The latest example is the so-called "harness case," in which several reputable business men and army officers were charged with fraud in a manner quite comparable to the construction cases more familiar to the readers of this journal. Last week United States Judge Groner told a jury that the defendants had overwhelmingly proved their innocence and that he would be a "craven and a coward" if he did not direct an acquittal and do all in his power to exonerate defendants so falsely accused. It is a sad thing that the victims of this persecution have no recourse other than the official vindication so emphatically given. One cannot help drawing an analogy to the cantonment cases, which have been dragging through the courts for over a year, the government losing every step in the legal process. Let us hope that the engineers and contractors will get full publicity of their vindication when it comes.

Hygienics of Sewage Sludge

ALTHOUGH the world over the utilization of sewage sludge for land fertilization is still the exception rather than the rule, notwithstanding the many attempts to that end for decades past, the subject is continually coming up. It has been considered more than ever since the activated-sludge process came to the front. Once sludge dewatering is put on a practical basis, as there is reason to hope it soon will be, then sludge utilization will present stronger and more numerous claims than ever before. Here and there the use of sewage sludge in agriculture has been opposed on hygienic grounds. The opposition has generally been based on vague claims of health menace. In view of the foregoing facts and implications, Mr. Wolman's extensive survey in the form of a report on the Hygienic Aspects of the Use of Sewage Sludge as Fertilizer, on p. 198, is most welcome. American and foreign regulations and data pro and con are presented and discussed, succinct conclusions drawn and the conclusions are offered as the basis for regulations to be promulgated by the Maryland State Board of Health. Mr. Wolman concludes that under not at all onerous rules sewage sludge may safely be used as a fertilizer. It is significant that most of the data bearing on the survival of dangerous conditions are twenty

years old or more. In later years more reliable methods of studying the viability of pathogenic germs have been perfected and the knowledge of the subject has been much increased.

Partnership or Bonus

CONTRACTORS wishing to encourage the more promising of their superintendents have made it a practice to organize new companies for new jobs with the favored subordinate as a partner. This is excellent encouragement to the young man getting ahead in the contracting business. The bankers and the surety companies, though, are pointing out a defect in this scheme and are recommending instead a bonus system for superintendents, especially when these superintendents are not able to bring in any capital to the partnership. The criticism of the partnership lies in the necessity of stabilizing the funds of the major partner. Such a contractor, for instance, has $40,000 of net quick assets and other assets equal to the same amount. He has four contracts under way of $100,000 each and four capable superintendents whom he wishes to interest in the work they will be in charge of either as a partner or under some bonus system. Suppose one of the four jobs strikes unexpected difficulties and it is to the best interests of the contractor if he can withdraw some of the earned profits from the good jobs to bolster up a bad financial condition on the losing one. He cannot legally do this without the full assent of his partners. In other words, his capital loses mobility, which not only has actual danger but the potential danger of affecting his surety risk.

More Rain Gages Needed

PAUCITY of rainfall data hampers the engineer in many important fields, compelling him to feel and guess his way where sums ranging from thousands to millions of dollars are involved. It is not merely that few of our rainfall records go back more than one to three or at best five decades. For vast areas there are scarcely any records at all. For elevated regions the scanty records become more scanty with increasing altitude and vanish with the heights. Important as are rainfall data in municipal engineering work, and variable as are the rainfall intensities on which depend economic sewer design, to come down to a concrete problem, few cities maintain rain gages of their own and fewer still in such numbers and so distributed as to give essential storm-sewer design data. This fact stands out in the paper on "The Distribution of Intense Rainfall and Some Other Factors in the Design of Storm-Water Drains" read before the American Society of Civil Engineers o Jan. 17 (*Proceedings* Am. Soc. C. E., January, 1924). Mr. Marston states that "only a few cities have more than two recording rain gages" and shows that in some at least of the cities where this number is exceeded they are too far apart or fail otherwise to give the desired data as to the distribution of intense rainfall in the various parts of the areas that would be considered in designing a district storm-water sewer system. Can it be that the costs of installing and maintaining automatic recording rain gages and of making use of the data they yield is so great that any city cannot afford to provide itself with as many as its area, topography and other conditions may require in order to obtain reliable rainfall records?

Civilian Engineers for Civilian Work

IT IS becoming increasingly apparent that the campaign for a federal Department of Public Works is to succeed or fail on the issue of the removal of non-military engineering activities from under the control of the Corps of Engineers of the army. Not that there are no other complications; there are many, including the most serious one of the reluctance of any government superior official to give up any of his power or prerogatives. But the gage of battle has been specifically thrown down before the army by the civilian engineers, and the Corps of Engineers, quick to defend its entrenched position, has taken it up. The Corps' tradition is honorable, its esprit de corps high, its influence great; it will fight with the long experience it has gained in the ways of Washington.

It would be a deplorable thing to have Congress come to believe that this is merely a struggle for power between the two fundamental branches of the engineering profession, or that it is merely an effort on the part of jealous civilians to usurp certain work from which they are now barred. Nothing would so lower the profession in the eyes of the country or defeat more readily any reforms of whatever nature that engineers may in the future advocate. But unless Congress is made clearly to see that engineers are striving for the greater good of the country through a more efficient management of its public works and that as a move toward that it is desirable to break the monopoly that the army has on certain work, the representatives at Washington will surely label this merely intra-professional warfare and therefore best left alone.

Just why is it that so many civilian engineers want to see the river and harbor work, the engineering of the City of Washington, the engineering of the Federal Power Commission, put under civilian control? The officers of the Corps of Engineers are all good Americans, sprung from the same stock as the rest of us, picked by our Congressman to be educated at public expense, subjected in their college days to a more rigid regimen than most college boys receive, and turned out at twenty-two or thereabouts to be low-paid servants of the government for thirty years or so and then retired on a small annuity. They are neither better or worse than their contemporaries who became engineers according to civilian methods. West Point, to be sure, is not an engineering school, but nowadays most of the Corps are required to take supplementary training at engineering schools, and the way the trend of thought in engineering education is now going this may be superior to the conventional technical course. The West Point graduate, taken into civilian work just after he has finished his post-graduate technical course, ought to be the best possible material for engineering success.

Nor can the Corps be justly criticised because it is hide-bound, tied together with red-tape, constricted with formalism. It is all these things, but so are all government institutions. That is the trouble with government—and it is a trouble that several thousand years of civilization has not been able to overcome. A civilian department of public works would be afflicted with the same disease, though not to the same degree, because such a department would be more flexible, more widely diversified, and not bound down by the aristocratic idea of government by the select few.

Herein, we believe, lies the real trouble as an engineering organization with the U. S. Engineer Department, of which the Corps of Engineers is the ruling class. It is an aristocracy; not an aristocracy of birth or of brains, but an artificial aristocracy of uniform, a selected few who move in the upper atmosphere of supervision and reward and, to be sure, of responsibility, with a much larger lower stratum of capable men who cannot by any chance ever rise above the limits set. And worse still, entry to this upper stratum is direct, so that the favored ones in it never have either the experience or the hardship of existence below. Not only can the competent civilian subordinate never rise above a certain level, but the uniformed superior, be he competent or not, never knows what it is to be a subordinate, except to his own class.

From this fundamental evil of a military organization spring all the lesser evils of the Corps. Its members, however well educated and however brilliant, have never known the struggle toward the top through the routine of engineering existence. Except for the exceptional man, this is a crowning disability. Because of the concentration of authority in a few, those few become narrow and their policies and principles become more and more governed by the traditions of their caste; bureaucracy therefore has its most encouraging medium in which to grow. And finally, because the subordinate can never rise to the top, his spirit is restrained, his ambition deadened and his initiative killed, which is the most serious condition of all, because by the very nature of the organization it is upon the subordinate that the basic engineering work falls.

All this is said without reference to personalities. In the Engineer Corps are some of the most capable engineers of today. The subordinates, too, have their quota of excellent engineers, faithful men, whose love for their work has risen superior to their hope of reward or ambition for success outside their chosen line and who carry the burden of many a division or district office. But the system is wrong and had it never been established no one could be found to defend it. It is true that the Corps has an enviable record of honesty, that it is unapproachable except along the road of technical argument, that its members go when they are told to go and come when they are told to come, and that those in authority know all this and appreciate what these qualities mean to a government. But these same qualities would inhere in a properly established civilian department, with tenure of service guaranteed, with gradually increasing rank and pay, with severance of political control and with proper retirement provisions. And such a department would be open to any qualified engineer and the lowliest member might in time rise to the head, which is the essence of this country's meaning.

In such an organization, too, the army engineer could find his place, rising with his civilian associates, trained in many kinds of engineering and not the single one which now engages practically all of his attention not directed toward military matters, and fitting himself by application to the multifold activities that are the part of the military engineer in modern war, which after all, is what the army is for.

The civilian engineers of this country have no malicious animosity against the army engineer. He is of the profession and as an individual they admire him. They would like to see him more a part of the profession, and not a museum piece, set off in his own little corner. And then if war comes, and they have to serve under him, as they know they must, they will have more confidence in his breadth of vision and background of training than they have with their present knowledge of his typical career.

A Defective Dam

SINCE the first news of the great dam break in upper Italy last December, with reports of whole communities devastated and hundreds of lives lost, no tangible facts about this startling engineering accident have found their way into print. The account which we are able to present in this issue, from information gathered by an Italian engineer on the ground, gives the first particulars of the structure and its failure. Apparently because of the governmental investigation which has been set on foot, the account lacks many pertinent details, so that it is hazardous to draw conclusions as to what was at fault. The difficulty is aggravated by the magnitude and unusual character of the structure, and the irregular procedure followed in building it.

Two features emphasized in the account are significant, aside from the general lack of competence in planning and construction to which the reporter refers. These are the use of a gravity base for part of the dam and the bad workmanship and ignorance of sound construction practice evidenced in the use of lime mortar in the base masonry and the acceptance of poor concrete in the superstructure. As to the first, the presence of this lime-mortar masonry foundation was so obviously a grave threat to the stability and permanence of the dam that one naturally looks first to the probability of initial failure here. So far as present evidence goes, however, the masonry in large part survived the failure of the dam, which indicates that it was not the primary cause of the disaster. This is particularly important with respect to the right-hand end of the base, where the eye-witness account suggests that the failure began. The possibility of vertical movement between the central part of the dam and the wings, due to the presence of this base, also comes to mind, though on the present data such settlement is purely conjectural.

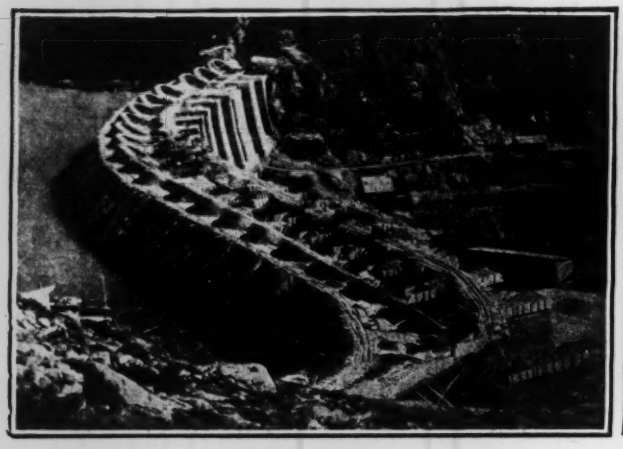
There is also the possibility that the concrete superstructure itself failed; in particular the chance of shear failure in one of the high buttresses invites consideration. It is worth pointing out that the portion of the dam which failed is the highest section, the wings being appreciably lower, and that the greatest stresses, and the largest influence of defective concrete and poorly bonded construction joints would be found in this part.

While the technical questions involved in the failure can not be answered even tentatively in the absence of fuller details—which the government's investigation will doubtless reveal—it is necessary to restate and re-emphasize the long-known truth that incompetent hands rarely build safe dams. The past has given many significant warnings that dams are hazardous structures, and can be made safe only through rigid enforcement of the principles that thoroughly skilled engineering must control both their design and their construction. Convulsions of nature have never destroyed a dam; negligence and error of their builders have destroyed many.

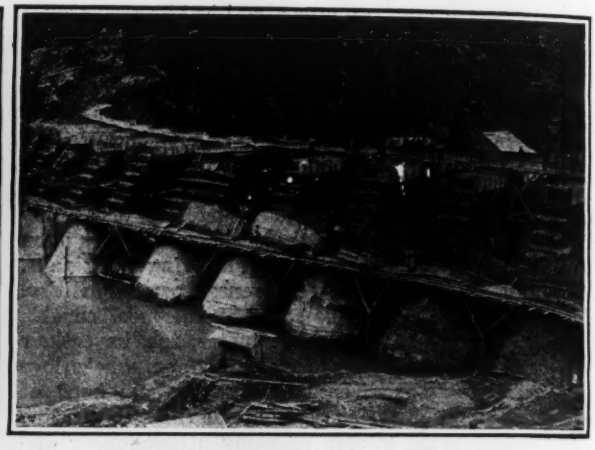
Details of the Failure of an Italian Multiple-Arch Dam

Disastrous Break of Reinforced-Concrete Structure on Masonry Base of Gravity Section — Plans Not Approved and Workmanship Doubtful—Base Laid in Lime Mortar—Superstructure Concrete Poor

ON DEC. 1, 1923, a 143-ft. power dam at Gleno, about 30 miles northeast of Bergamo, in north central Italy, failed suddenly. Great destruction was done by the escaping waters along the valley of the Dezzo River in the 12-mile length down to its junction with the Oglio River at Darfo, and minor damage from flooding was done in the Oglio Valley for the remaining 5 or 6 miles to its discharge into Iseo Lake at Pisogne. The Dezzo Valley is steep and narrow, and in places the flood wave reached a depth of 100 ft. The loss of life is estimated at 500, and the property loss at about 150,000,000 lire. Five power stations between Gleno and Darfo and a number of factories were destroyed, besides many houses and villages. The essential facts of the failure have been reported for *Engineering News-Record* by A. DeMartini, an engineer of Genoa, with the assistance of A. C. Janni, of New York.



GLENO DAM UNDER CONSTRUCTION, 1921



BUTTRESS CONCRETING AHEAD OF ARCHES

The Gleno dam, built after the war and only recently completed, was a reinforced-concrete structure of multiple-arch type resting on a gravity base of stone masonry. It was 143 ft. high above the stream, 863 ft. long on top, and of curved ground plan, comprising a circular central portion about 250 ft. long and straight end portions, tangent to the central curve. The reservoir back of the dam was of about 4,400 acre-ft., or 190,000,000 cu.ft. capacity. The location is high up in the mountains, the highest reservoir level being about 5,200 ft. above sea level, while Darfo is at 820 ft. and the level of Lake Iseo at 607 ft.

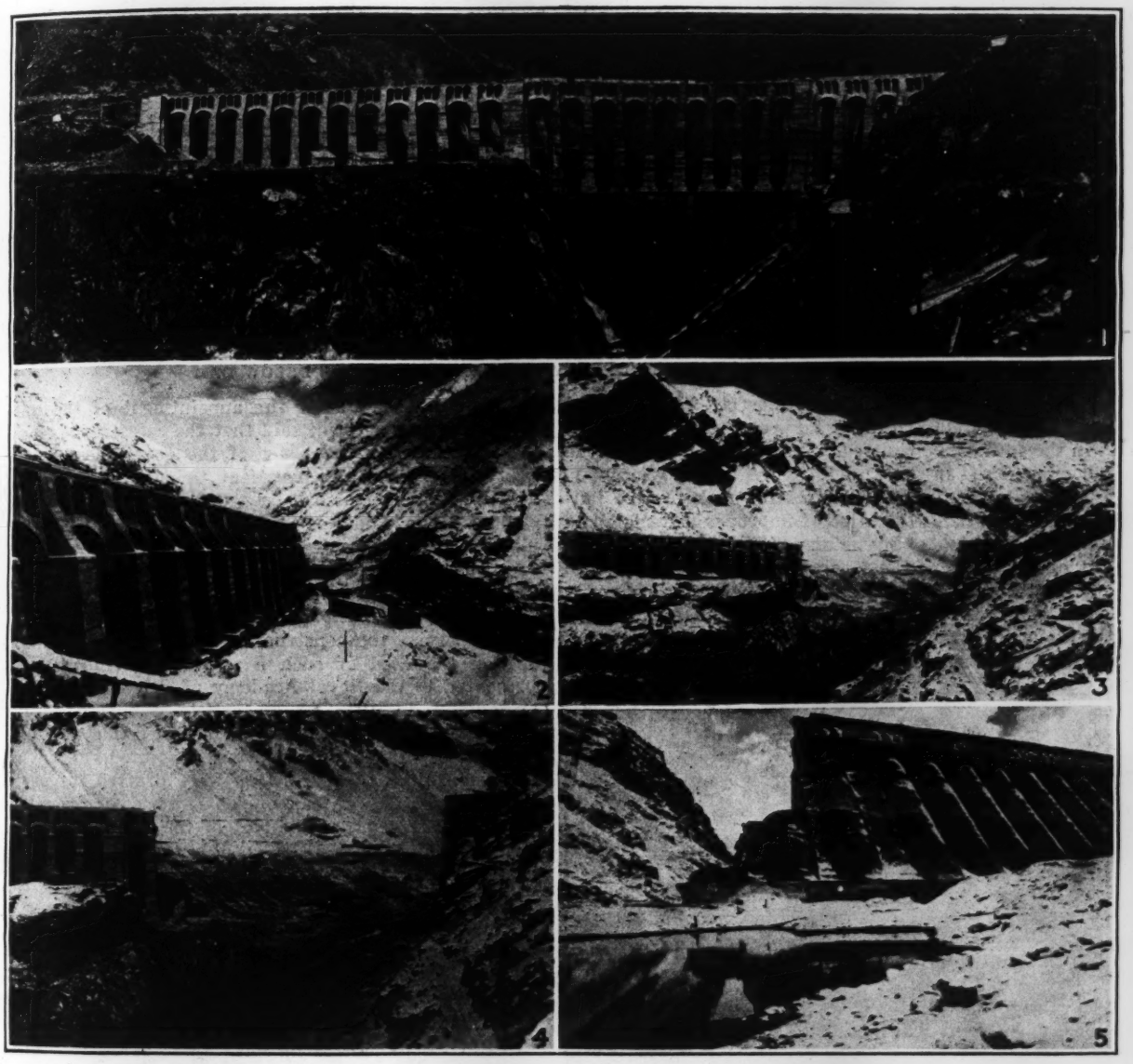
According to the original plan and the terms of the franchise granted, a gravity dam was to be built. Subsequently the company which held the franchise, the G. Viganò Co. of Vilminore, applied for a change in its franchise to permit the construction of a multiple-arch dam on the ground that its subsequent studies had shown this to be the preferable type. Authorization for the change was withheld pending submission of complete plans, but the company proceeded with construction, and later ignored government orders to stop construction until the plans had been approved.

Either because of the change of plan or to simplify construction by providing a horizontal base for the main part of the structure, the dam was built of a solid masonry base portion filling the lower part of the valley and a superimposed concrete multiple-arch structure. The masonry base was 52½ ft. high and about 250 or 260 ft. long. The curved part of the superstructure extended over this masonry base, while the straight flanking portions were founded directly on the rock of the valley side. The buttresses of the superstructure at the junction of straight and curved portions were made of extra thickness. The multiple-arch superstructure consisted of semi-cylindrical arches 26 ft. 3 in. in span between centers of buttresses and inclined 53 deg. to the horizontal. Of the 25 arches, nine formed the central curved portion, four the straight portion on the left bank, and twelve the straight portion on the right bank. Of these, nine arches fell, together with their buttresses. They were eight of the arches of the curved portion and the first arch of the tangent sections on the left bank; the heavy buttress at the point of tangency also went out. The masonry base in large part remained in place.

Eye-Witness Account—A watchman was on duty at the time of the accident, which was about seven in the morning. He had just gone down to operate a valve, and was walking along the masonry base when, in passing in front of the twelfth buttress from the left bank, not far from the junction buttress, he noticed some small pieces of concrete falling. Immediately thereafter he saw a crack open on the front of the same buttress, and barely had he passed it when it went out, carrying with it the two arches abutting on it. The mass of water in the reservoir surged out through the break, and in a short time tore out the remainder of the central portion of the dam.

In the rush of the waters down the Dezzo Valley to Darfo, 12 miles, everything in the valley was swept away. Power houses at Vilminore, Dezzo, Mazzuno,

Angolo, and Darfo were wrecked, and the Voltri steel works at Darfo were damaged. Rocks weighing many tons were carried for miles down the valley, and penstocks of the power houses were in part torn out and carried away. At Darfo the wrecking of the power house released the water in the penstocks, and the negative pressure developed in the upper part of the penstocks caused them to collapse, as may be seen on p. 184 (it is expected that these pipes can be forced back into shape by the internal hydraulic pressure after the power house is again ready for service).

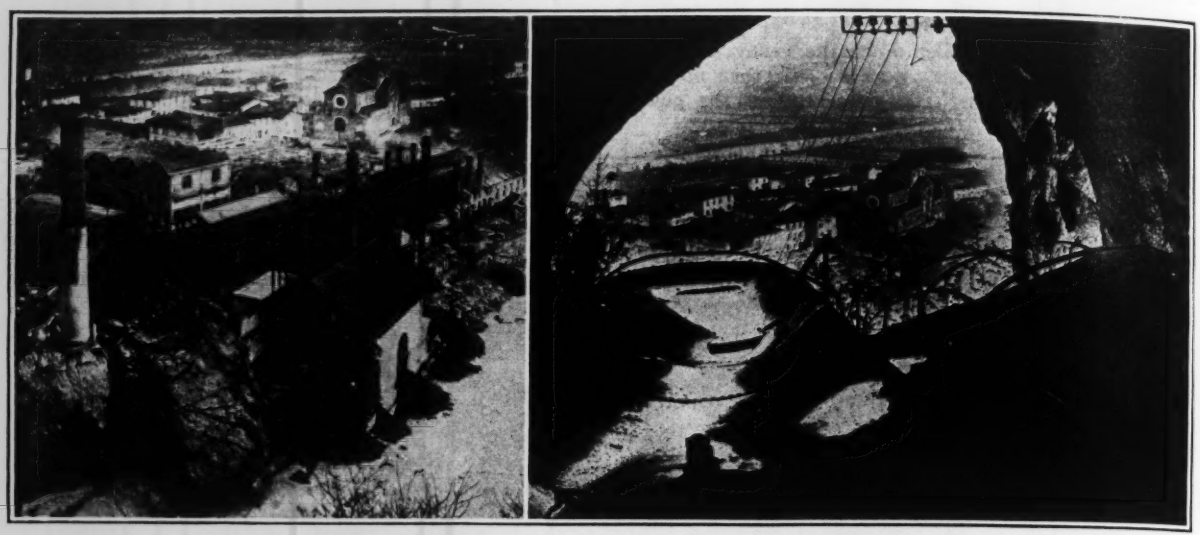


THE ITALIAN DAM DISASTER—GLENO DAM BEFORE AND AFTER FAILURE

1—Completed dam, in October, 1923 (looking upstream).
2—Failed dam seen from right bank.
3—General upstream view of failure.
4—The central washout, rear view.
5—Right flank of washout, where the break in the dam probably started.

Conditions and Causes of the Dam Failure—No precise statement of the conditions leading up to the break of the dam can be given before the official inquiry is completed. Certain facts are fairly well established, however. On the authority of a competent engineer of dams who visited the Gleno structure repeatedly, it may be stated that the work was badly executed.

The reinforced-concrete parts of the dam on either side of the masonry base were placed directly on the rock surface, without being trenched into the rock. The masonry of the gravity base was laid up in lime mortar, of lime burned near the site by the builders and transported to the dam by cableway. The specifications called for cement mortar. The gravel aggregate used in the concrete was not washed, and the concrete in the structure was porous. The reinforcement of the buttresses was scrap netting used during the war for protection against hand grenades. This same engineer stated that during construction one of the arches leaked, where a centering timber that projected into the concrete had been cut off flush with the face of the work.

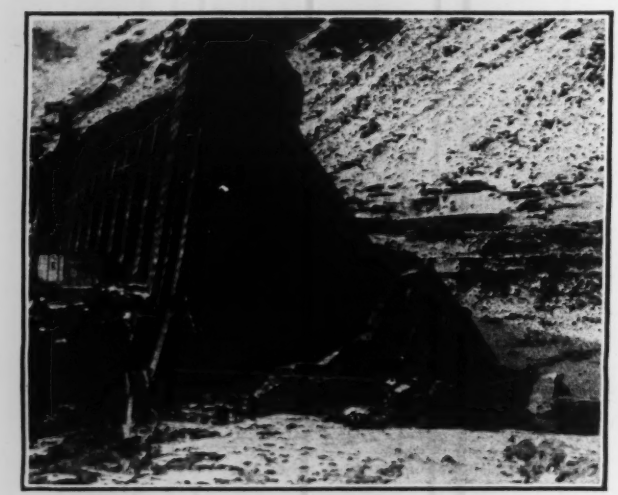


POWER-PLANT AND PENSTOCK DAMAGE AT DARFO, 12 MILES BELOW DAM

leaving its end embedded in the concrete. Hand-mixed concrete was used, and the usual precaution of ramming it in the forms was omitted. Summarizing, he lists the following faults in the work:

(1) Failure to cut footings in the rock for the buttresses of the dam; (2) Use of improper materials and lack of inspection of materials; (3) Poor mixing and lack of inspection of the concrete; (4) Use of unwashed aggregate; (5) Lax inspection in pouring the concrete; (6) Failure to ram the concrete in the forms; (7) Generally incompetent direction and supervision.

It has been suggested by some that tectonic disturb-



LOOKING AT RIGHT-HAND FACE OF BREAK; MASONRY BASE IN FOREGROUND NOT MUCH ERODED

ances may have contributed to the disaster. This belief is based in part on the fact that the rock floor of the valley, where earth and silt deposits have been washed away near the foot of the dam, show some cracks which are not believed to have existed previously.

Dam Construction to Be Studied—The Ministry of Public Works has appointed a committee to investigate this disaster and to examine all dams now under construction in Italy. It is composed of Camillo Guidi, G. Fantoli and C. Corza.

In an interview after the appointment of the committee, Professor Guidi said that the catastrophe would probably not have happened if the government in the past had created a department to supervise the construction of dams, as had been urged by an engineering committee on dams, of which he was chairman. The plan was that such a department should examine designs of all dams submitted to the government for approval, that authorization of the dam construction should depend on an examination, and that the government should also supervise the construction work. He gave warning on the need of such a step in 1917 in a paper presented to the Royal Academy of Sciences in Turin, and again in 1918 in an article published in the "Giornale del Genio Civile." Following this article, a committee on the subject was appointed, under his chairmanship, and regulations were drafted to govern the construction of dams. This work, however, received no attention on the part of the government until the present accident.

Long-Time Strength Tests on Alumina Cement

Tests on ciment fondu, the trade name for one of the French alumina cements, reported in a recent issue of London *Engineering*, show that the strength of concrete made from the cement increases consistently up to three years. The tests were made under the supervision of M. Le Gavrian, of the French Ponts et Chaussées, upon a concrete made up in the proportion of 400 kg. of cement, 300 liters of sand, and 900 liters of gravel (1:1.2:3.6); from 7.9 to 8.7 per cent of water was used. Two cements, the first received in the laboratory in October, 1915, and the other received in March, 1916, were used. The strengths in pounds per cubic inch were as follows:

Age When Tested	Cement A		Cement B	
	In Open Air	Under Water	In Open Air	Under Water
1 day	.....	.....	1,673	.....
2 days	.....	.....	3,520	.....
3 days	4,444	3,945	4,622	3,700
7 days	4,480	4,551	6,080	5,880
28 days	5,260	4,727	7,685	7,360
90 days	5,510	5,180	8,365	8,020
6 months	6,040	.....	8,900	8,600
1 year	6,631	.....	9,353	9,103
2 years	6,827	.....	9,493	8,96-
3 years	6,730	.....	9,707	9,350

Square and Triangular Cement Storage Warehouses

Floor in One Placed on Cinder Fill Saves $45,000—In Other Moisture Condensation Limited by Minimum Openings

REINFORCED cement-block walls, encased steel columns, a composition roof to prevent condensation of moisture, ventilation of the floor and provision for loading from three sides were features in the design of a cement storage warehouse and transfer dock recently built at Davenport, Iowa, for the Marquette Cement Manufacturing Co. The company has also built in Chicago, at Elston Ave. and Redfield St., a rectangular storage warehouse with the floor at the usual car-body height on a cinder fill enclosed by a retaining wall, thereby saving $45,000 over the usual design of a floor supported on piers.

The Davenport triangular structure covering an area of 66,000 sq.ft. was designed for the exclusive storage and transfer of cement in bags. An underlying limestone ledge at an average depth of 3 ft. below the ground level covers the entire property and furnishes an excellent foundation. The floor, which is 4 ft. above the established street and track levels and approximately 8 ft. above the original property grade, is of two-way, flat-slab type designed to sustain a uniform live-load of 800 lb. per square foot. Typical panels, 15x16½ ft., with the long dimension parallel to the building line gave uniform spacing on all exterior walls with irregular bays at the lines of the intersections comprising only 15 per cent of the total number of panels. This arrangement reduced the irregular formwork to a minimum.

Structural steel columns resting on piers, built up from the limestone ledge, girders and purlins support the built-up composition roof. Exterior steel columns are encased in concrete to form wall pilasters. While the lintel and belt courses were concrete cast in place, the wall panels were "granite faced" cement block reinforced by horizontal bars spaced every two blocks in height at the center of the wall. The ends were anchored to the wall columns. The reinforcing was placed to take care of stresses set up by any possible shifting of the stored material.

Under-floor ventilation was provided for by screened openings with controlling louvers placed in all exterior walls.

Switch tracks run along two sides of the building which has the shipping doors at car-floor level permitting the simultaneous loading and unloading of fourteen cars. On the remaining side six enclosed docks open directly from a paved highway for local truck and team delivery.

In a line with the usual scheme of design and the requirements of the Chicago Building Code, the floor in the Chicago warehouse would have been supported on piers extending with their foundations from a level of at least 4 ft. below grade and also supporting the columns of the roof construction. In deviating from this design a retaining wall was built around the site extending from a level of 5 ft. below grade to the floor line, its outside face being on the building line. The area so inclosed was filled in with clean cinders, deposited in 12-in. layers, and each layer rolled with a 10-ton steam roller. A 12-in. reinforced slab, forming the floor, was laid directly on this fill and tied into the retaining wall.

The steel skeleton of columns, girders and beams supporting the roof was set and anchor bolted onto this floor slab. Spandrel beams at the roof level were incased in concrete forming a concrete parapet wall. The rectangles between floor slab, parapet wall and pilasters were filled in with screen walls of hollow concrete blocks 16 in. long, 8 in. high and 12 in. thick. As the only openings are the loading doors, the lighting is artificial.

TRIANGULAR CEMENT STORAGE WAREHOUSE AT DAVENPORT, IOWA

Switch tracks on two sides and six enclosed docks for local truck and teams on third side.

All this is done to furnish the greatest protection against moisture.

The Davenport warehouse was designed and construction was carried out under the supervision of Neiler, Rich & Co., engineers, and J. J. Davey, architect, both of Chicago. The Priester Construction Co., Davenport, was the contractor. L. E. Ritter, consulting engineer, designed and supervised the construction of the Chicago warehouse.

Fish and River Pollution in England

To protect fish against river pollution in England, the streams of that country have been divided into three classes by the Ministry of Agriculture and Fisheries. A preliminary report of the Standing Committee on Rivers Pollution, appointed at the end of 1921 (abstracted in the London *Surveyor* for Jan. 11, 1924), states that the committee has divided the rivers of the country into three classes: (1) Those sufficiently pure to support a considerable stock of fish; (2) those polluted, but nevertheless still containing a certain number of fish; (3) those grossly polluted and containing few, if any, fish. Owing to the shortage of time and staff, the committee has concentrated its attention on rivers of the second class. Before the committee had gone far in its work it found that it "lacked the local knowledge and local influence necessary to deal systematically with each source of pollution." Accordingly it has "promoted the formation of local sub-committees representative of local interests to be responsible for individual watersheds. Each sub-committee has the services of an investigator with scientific qualifications whose work is carried out under the direction of the standing committee's technical advisor." Already the interest and cooperation of a number of different plants contributing industrial wastes to the pollution of rivers have been secured.

Progress on the Union Station at St. Paul, Minn.

Headhouse and Half of Elevated Track Structure Completed—Ballasted Station Tracks on Concrete Deck

ABOUT 50 per cent of the reconstruction of the union station at St. Paul, Minn., was done with the completion of the work for 1923. There were then eight stub and four through tracks (out of a total of twenty-four tracks) on the new elevated deck of the station structure, the other tracks being still operated temporarily on the lower level. The remainder of the work is under contract and is to be completed by 1926. Fig. 1 shows the structure for the waiting room and concourse, with stairways to the platforms below. In daily traffic this station has from 165 to 170 main-line trains and 60 to 65 suburban trains, the rush-hour numbers being 32 for the former and 7 for the latter. Main-line passengers average 6,600 daily and 1,000 during the rush hour, the maximum being 25,000 and 3,000 respectively. Suburban passengers average 5,500 daily, with 4,000 at the rush hour. The baggage handled daily averages 4,850 pieces, with a maximum of 7,000 pieces.

Enlargement and elevation of the St. Paul Union Station to improve its facilities and eliminate street crossings at grade was decided upon several years ago, but considerable time was spent in negotiations and the discussion of different projects, until in February, 1917, the present plan was adopted, as shown in Fig. 2 (see *Engineering News-Record*, June 7, 1917, p. 486, and June 20 and 27, 1918, pp. 1184 and 1221). The old station, at street level, occupied 735,000 sq.ft south of Third St. and its headhouse fronted on Sibley St. This site has been enlarged to 1,262,000 sq.ft., including an entire block north of Third St. for a new headhouse. In this separation of the headhouse from the trackage section the arrangement is like that of the new Union Station at Chicago (*Engineering News-Record*, Dec. 6, 1923, p. 928), except that in the latter the connection with the concourse is by a subway while at St. Paul this connection is by a bridge.

For the new station the tracks are elevated about 20 ft. above the old grade and in the station proper they are supported by a concrete deck on columns, with baggage rooms and other facilities below. The station yard and approaches have a solid fill between concrete retaining walls, with bridges across streets leading to the water front. Typical construction of the track deck, shown in Fig. 3, consists of a 21-in. concrete slab supported by columns spaced 21 ft. c. to c. in both directions. Platforms built on this deck have 6-in. walls and slabs, with cinder fill; the platform slabs have wire mesh reinforcement and a ½-in. surface finish of 1:1 cement grout.

Eight stub tracks and fourteen through tracks will provide for passenger service, in addition to which there are two through freight tracks along the river front. At the east end the twenty-two station tracks will converge on a seven-track throat opening into a Y for main lines leading north and south. At the west end, the sixteen through tracks will converge on a four-track approach. Station tracks are arranged in pairs, alternating with eleven platforms 19½ ft. wide, the track spacing being 12½ and 29½ ft. c. to c. alternately. The concrete platforms are low, with butterfly shelters composed of steel posts and frames with timber sheathing. Details of platforms and shelters are given in Fig. 4.

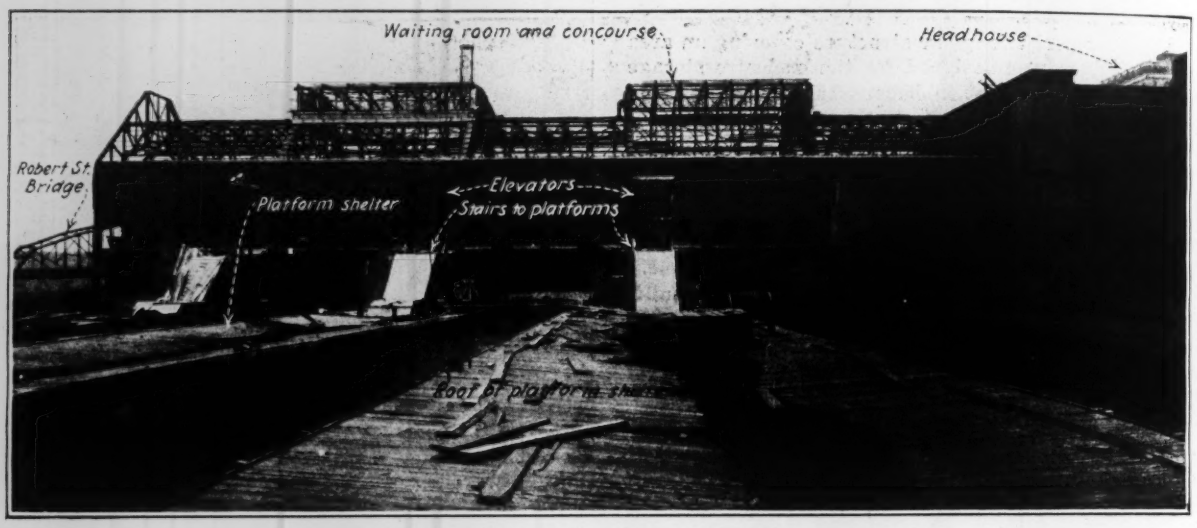


FIG. 1—CONSTRUCTION OF NEW UNION STATION AT ST. PAUL

Elevated concourse and waiting room, with stairways to platforms; completed portion at right, with headhouse beyond. Platform shelters in foreground. Robert St. bridge over Mississippi River at left.

Ballasted track construction is employed, although many large modern stations have the concrete deck bare, with rails carried on short blocks embedded in the concrete. At the St. Paul station, creosoted ties are laid in washed gravel ballast, as shown in Fig. 3. The rails are of the 90-lb. A.R.E.A. section, in 33-ft. lengths, resting on metal tie-plates and secured by cut or drive spikes. The switches have 16½-ft. switch rails and No. 8 frogs, except that No. 4 frogs are used in the diamond crossings and slip switches.

The four-story headhouse, 150 x 300 ft., is of reinforced concrete with stone facing. Its main floor is level with Fourth St. and about 26 ft. above Third St., with a bridge leading to the waiting room and concourse which are arranged in a structure spanning the tracks (see Figs. 1 and 2). Each platform is served by a stairway from the concourse. In the space between

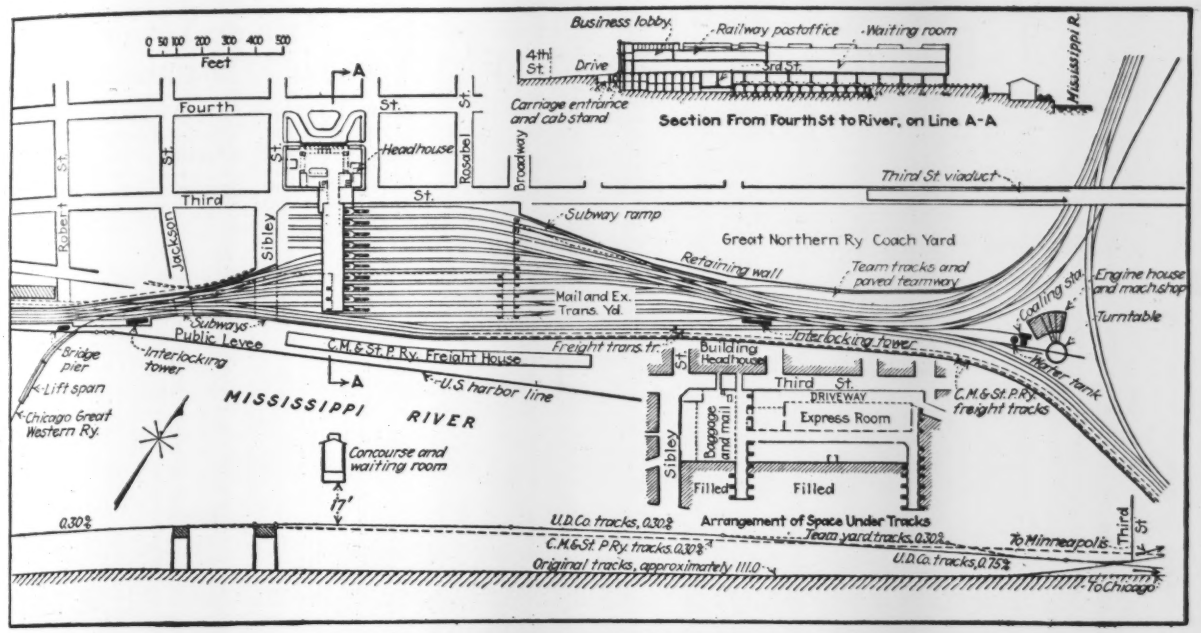


FIG. 2—GENERAL PLAN OF ST. PAUL UNION STATION

the Y-tracks at the east approach are a five-stall engine-house, machine shop, 85-ft. turntable, ashpit, tank and coaling station to serve the switching and transfer engines of the St. Paul Union Depot Co.

For convenience of the railroads and the public, the construction program was divided into six consecutive periods or units, but no definite time was assigned for each unit. Work started in 1917 was delayed under government administration of the railways, but was resumed in August, 1918. The first unit consisted of the headhouse, which was opened for service in April, 1920. The second unit comprised a part of the waiting room and a six-track section of the elevated deck, with baggage and waiting rooms below. This was completed in November, 1921. Further work was then postponed on account of unfavorable financial and commercial conditions.

A contract for the remaining four units was let in March, 1923, at about $4,000,000, all work to be completed by 1926. The work assigned for 1923, as Unit No. 3, included the second portion of the waiting room, the second six-track section of the elevated deck, connection to the four-track elevated west approach, some retaining walls and the engine terminal. These new facilities, costing about $2,000,000, will be put in service early in 1924. Units 4 and 5 include principally the completion of the waiting-room and the filling for the elevated track structure. Unit 6 includes the completion of retaining walls, fill and approaches, and also the connection with the Mississippi River bridge of the Chicago Great Western Ry., which the railroad will raise to the new track level.

The joint contractors for the first two units were Morris, Shepherd & Dougherty and the George G. Grant

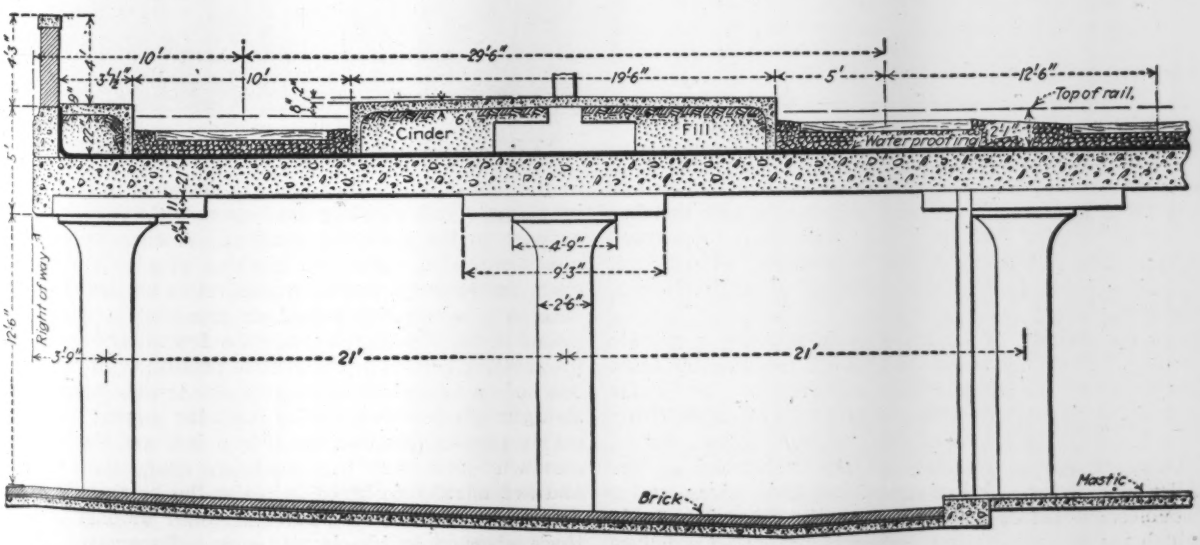


FIG. 3—TYPICAL CONSTRUCTION OF TRACK DECK

Co., St. Paul, at about $5,300,000. The contract for the other four units was awarded to Foley Brothers, St. Paul, at about $4,000,000. Including $4,700,000 for land, the total cost of the station will be approximately $14,000,000. Nine railroads use this station and are

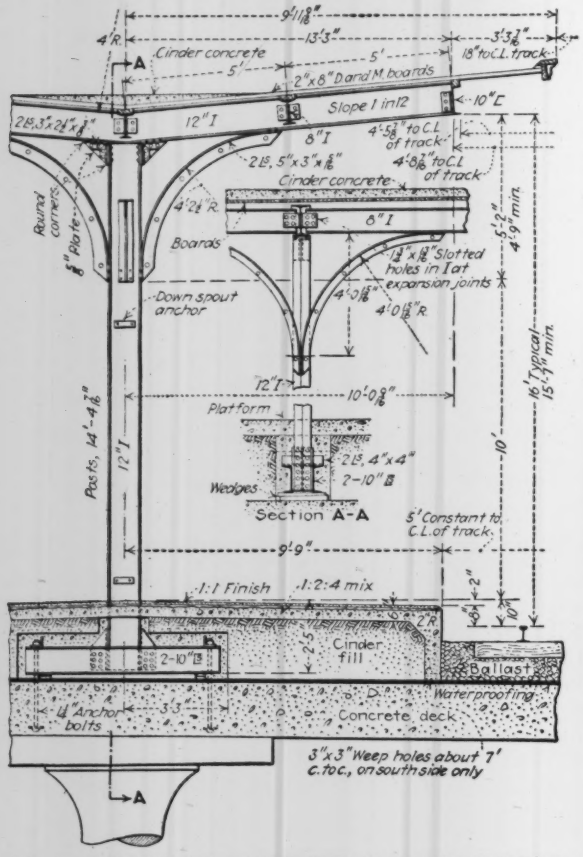


FIG. 4—PLATFORM AND SHELTER, ST. PAUL STATION

represented in the St. Paul Union Depot Co., the president of which is Ralph Budd, president of the Great Northern Ry. The chief engineer is Col. Frederick Mears, who succeeded the late W. C. Armstrong; G. H. Wilsey is principal assistant engineer; Charles S. Frost, Chicago, is architect, and Heiler, Rich & Co., St. Paul, are the consulting mechanical and electrical engineers.

Allegheny National Forest Created

The creation of the Allegheny National Forest by a proclamation of President Coolidge on Sept. 24 brings the total number of national forests to 146 and the total net area of such forests to more than 157,000,000 acres. The Allegheny forest boundaries, as outlined, include a gross area of about 740,000 acres in Warren, McKean, Forest and Elk Counties. This forest is to be built up entirely of lands to be bought from private owners. Thus far about 100,000 of the 740,000 acres proposed are under purchase agreement. A circular issued by the United States Department of Agriculture, which has jurisdiction of the national forest, states, "This acreage is situated on the watershed of the Allegheny River, a tributary of the Ohio River, and a troublesome factor in the frequently recurring floods which menace navigation, industry, property, and lives in the region centering at Pittsburgh."

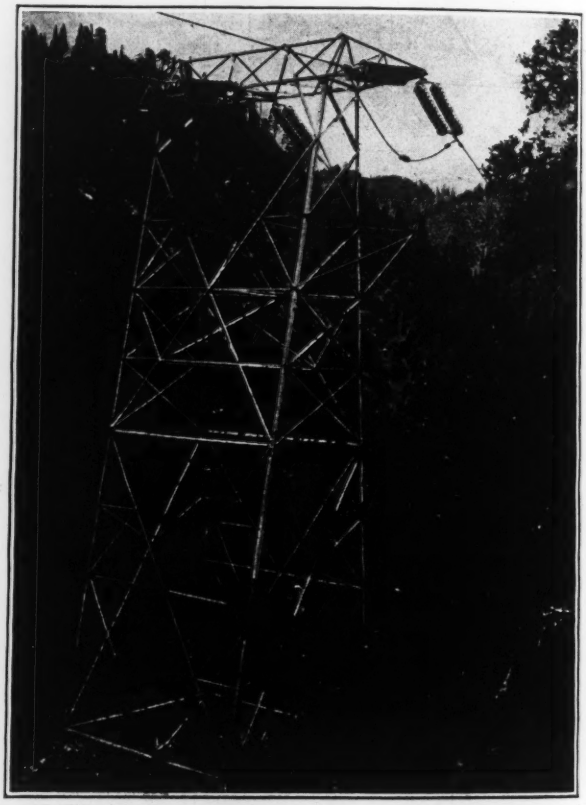
Comparative Data on Towers for High Tension Transmission

Single-Circuit and Double-Circuit Towers for 220-kv. and 110-kv. Lines—Towers for Special Problems

BY WALTER DREYER
Assistant Civil Engineer, Pacific Gas & Electric Co., San Francisco

This article supplements the article entitled "Modern High Tension Power Transmission Lines" which appeared in the issue of January 3, 1924. —EDITOR.

THREE TYPES of standard towers that are in general use are the dead-end tower, anchor tower and straight-line type. Dead-end towers are used at angles



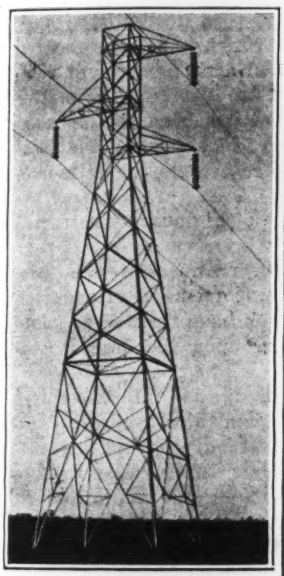
TYPICAL DEAD-END TOWER ON 165,000-VOLT LINE

in the transmission lines and are designed to resist the breaking of all wires in one span, with the insulator support in the dead-end position. Anchor towers are also designed to resist the breaking of all wires in one span, but have the insulator support in vertical suspension to give a reduced load on the tower. They are placed in the line at intervals of a few miles to prevent progressive failure in the remote possibility of the failure of a standard straight-line tower. Standard straight line-towers have the insulator support in vertical suspension position to give a load on the towers somewhat less than the maximum conductor tension, and are usually designed to resist the breaking of one or two wires on a single-circuit tower or one, two or three wires on double-circuit towers. Experience of the Pacific Gas & Electric Co. has shown that where the

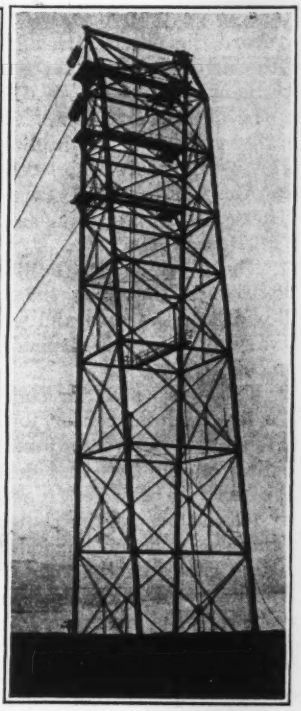
DATA ON STANDARD TOWERS OF PACIFIC GAS AND ELECTRIC CO.

	220-Kv. Tower lines				110-Kv. Tower lines			
	Single-circuit towers		Double-circuit towers		Single-circuit towers	Double-circuit towers		
	Type SA	Type SC	Type M	Type 0-98	Type S	Type AH	Type BH	Type CH
Height (ft.)								
Overall	55½	55½	97	98	49½	83	83	83
To lower crossarm	51½	51½	62	63	48	58	58	58
Width, ft.								
At base	20x20	20x20	20	20	14x14	16	16	20
At crossarm	4x20	4x20	6	6	2x14	4½	4½	4½
Conductor separation (ft.)								
Between phases	19	19	15	15	13½	10	10	10
Between circuits	..	..	24	24	..	17½	17½	17½
Conductor								
Max. size (copper)	500,000 cm.	500,000 cm.	500,000 cm.	500,000 cm.	3-0	250,000 cm.	250,000 cm.	250,000 cm.
Loading	8 lb. wind ½ in. ice	8 lb. wind ½ in. ice	8 lb. wind no ice	8 lb. wind no ice	6 lb. wind 1½ in. snow	8 lb. wind no ice	8 lb. wind no ice	8 lb. wind no ice
No. broken	3	3	3	6	2	3	3	6
Span								
Normal	500	500	800	800	400	800	800	800
With angles	....	1,000	....	800	....	....	800	800
Max. on tangents	750	1,500	1,000	1,800	400	1,000	2,000	2,500
Max. contributing weight	1,500	2,100	1,050	1,800	400	2,000	2,500	5,600
Max. Angle	None	22½ deg.	None	22½ deg.	None	None	15 deg.	45 deg.
Type of Conductor Support	Suspension	D. E. or susp.	Susp.	D. E. or susp.	D. E. or susp.	Susp.	D. E. or susp.	D. E. or susp.
Weight of Tower	5,100 lb.	7,270 lb.	8,440 lb.	12,950 lb.	4,250 lb.	5,080 lb.	6,200 lb.	7,590 lb.
Foundations								
Concrete (cu.yd.)	6.28	11.8	7.8	15.2	11.2	6.72	8.72	12.9
Excavation (cu.yd.)	18.1	60.4	25.5	84.5	32.5	22.4	31.2	44.4

wires of a circuit are in a vertical plane, the breaking of the top wire will often bring down all three. It has, therefore, become their practice to design their double-circuit towers to withstand the load due to the breaking of three wires of one circuit.



TYPICAL STRAIGHT-LINE TOWER (ABOVE)



TOWER FOR 4753-FT. SPAN AT CARQUINEZ STRAIT (RIGHT)

In order to give an idea of the comparative sizes, weights and foundation requirements of 110,000-kv. and 220,000-kv. line towers the table of data on standard towers of the Pacific Gas & Electric Company is included.

Special Problems—In most transmission construction there are special long span crossings requiring the use of high towers designed for heavier loads than the standard. The 165,000-volt line of the Great Western Power Co. crosses Carquinez Strait near Benicia on a span of 4,753 ft. The conductor is steel core aluminum and is supported by dead-end insulators consisting of eight standard strings yoked together. Coiled springs are used to equalize the tension on each of the eight strings and to reduce vibration. This tower is shown in the illustration.

The Big Creek line was originally constructed with allowance for 25 ft. ground clearance. In reconstructing the line it was necessary to increase this to 30 ft. in all country which could be used for cultivation. This work was done by raising the towers bodily without interfering with service. The foundations were left undisturbed, the necessary extension being made with the tower legs vertical. A description of this operation was published in *Engineering News-Record*, June 12, 1923, p. 1055.

The heavier loading of the higher voltage lines presents difficulties not encountered in earlier construction and requires more careful analysis of the foundations to take care of the horizontal forces.

Other problems, such as the transposition of conductors on high voltage lines, need special construction.

Designing for Future California Traffic

Extracts from an address before the Commonwealth Club of San Francisco, by R. M. Horton, Chief Engineer, California Highway Commission.

WE ARE at a loss to know how far in the future to look in the design of highways. Based on the increases of the past five years, by 1930 California will have operating over its highways about 4,000,000 motor vehicles. Many think the saturation point in the number of automobiles will soon be reached; perhaps stable conditions will be reached when there is one automobile for each family. However, it is doubtful whether it would be wise for the commission to proceed now to fix the standard in pavement construction to provide for such enormous increases in automobiles. Rather the endeavor in all construction and reconstruction is toward betterment of alignment and curvature, additional width of graded section, and culvert lengths such as will permit 50 per cent increase in future pavement width over that now being laid.

The deterioration of California pavements would not have been so serious had the original construction been to a width of 18 or 20 ft. rather than 15 ft. No pavement planned at the present time on the state system will be less than 18 ft. in width and this only on secondary roads. The more important roads will have a minimum width of 20 ft.; the center thickness will be 6 in., deepened to 9 in. at the edges. This is not regarded as being standard and thicker sections are being used in many locations.

Reinforcement Checks Cracking of Concrete Pavements

Weight and Bond Vital Factors—Location Affects Efficiency—Faulty Placing Common—Prime Purpose Not Strength But to Prevent Cracking—Ideal Construction Described

By W. S. Edge
Concrete Steel Co., New York, N. Y.

REINFORCEMENT for concrete roads is a live subject and a discussion like that of H. E. Breed in *Engineering News-Record*, Nov. 15, 1923, p. 790, deserves careful attention. Mr. Breed, in this article, refers to a broad experience with roads reinforced with one class of steel reinforcement, namely, mesh, or shop-assembled steel fabric. This article is planned to show the results which have been secured by the use of reinforcement of a number of different classes, including the special type which has largely been employed by Mr. Breed. It is based on the experience of the author's company in furnishing reinforcement of many types for highways of every class and the data cover more than 500 individual highway contracts and over 1,000 miles of reinforced-concrete roads.

The company's connection with this work was usually simply that of subcontractor furnishing the reinforcing steel and it was usually furnished to meet the designs of others. In a few cases the company's advice was sought and in this manner it was enabled to try different arrangements of reinforcement and different percentages of steel. The contracts cover practically every size and type of reinforcement from weights of 30 lb. per 100 sq.ft. to two-layer reinforcement weighing as much as 160 lb. per 100 sq.ft. In some cases reinforcement in a single layer was placed in the bottom. In other cases it was placed near the top. In still other cases it was placed close to the middle of the slab and a great many highways were reinforced heavily top and bottom.

While the company did not have the inspection of any of this work in a strict sense yet its engineers have visited nearly all contracts during construction one or more times and, since completion, the writer and his assistants have inspected all of the more important highways at least once so that they have an idea of how the work was carried out and of the present condition of the road. The work with which the company had a direct connection covers the past three years and the writer has in addition inspected many of the eastern highways which were reinforced with mesh and constructed several years previous to the first contract in which bar reinforcement was employed.

Wire Fabric or Deformed Bar Reinforcement—In Mr. Breed's article there is a reference to the grade of steel and tests are quoted which seem to show that the wire of which fabric is made has superior physical qualities. Of course this question has often been raised before in connection with reinforcement for concrete buildings and structures, and if an engineer prefers a high elastic limit he can secure this in deformed bars just as readily as he can secure it in a wire fabric and at no greater cost than the softer or structural grade steel. This has long ago been recognized in general reinforced-concrete construction and the type of reinforcement to be employed is determined purely by economic considerations and by the preference of the contractor who has to purchase and install the material.

There is, however, one consideration which is important. A welded fabric, on account of the rigid attachment of closely spaced members, has an excellent bond with the concrete which is not possessed by the smooth cold-drawn wire itself. This superior bond is furnished in a very high degree by deformed bars and there is no question at all, through the results of experience, but that deformed bars of any type are superior to plain bars in concrete road construction. This is so because the bond is a very important element and if cracks do develop in a reinforced slab it is highly important that they be small and well distributed. These results have been secured by the use of deformed bars and welded mesh of sufficient weight.

Results from Service—It is not the purpose of this article to go into the theory of road design but rather to record the practical results which have been secured by the use of various types and arrangements of reinforcement so that others who are studying the matter may be advised of exactly what has been accomplished by the various state highway departments and local highway engineers who have been employing reinforcement for a number of years.

There are two general classes of highways constructed of reinforced concrete:

1. Those which are built with unbroken slab from side to side in which the reinforcement extends the full width of the road and which have transverse joints at varying intervals depending upon the design, location, etc.

2. Those in which the slab is divided into two halves by a longitudinal center joint and also separated into sections by transverse joints at varying spacings depending on the type and design. In this case the two slabs may be doweled together or the reinforcement may extend across the center joint serving as a dowel or there may be no bond or contact whatever between the two halves of the road.

It is obvious from the very nature of the case that these two types of road require radically different treatment to secure equally good results.

The writer cannot agree with Mr. Breed's contention that the reinforcement should be substantially equal in both directions, as we find that this depends entirely on circumstances. A 20-ft. road in our northern and eastern states requires considerable transverse reinforcement to prevent the formation of a longitudinal center crack. If this road is divided by a longitudinal joint the transverse reinforcement may be materially reduced without danger providing sufficient transverse reinforcement is placed adjacent to the transverse joints. The amount of longitudinal reinforcement that should be used depends entirely on the length of sections which it is desired to employ. If transverse joints are to be located 40 ft. apart a moderate amount of longitudinal reinforcement will prevent the formation of transverse cracks if it is properly placed. If it is desired to build transverse joints 150 ft. apart, a very

much larger amount of longitudinal steel must be employed. This accords with the general theory of reinforced-concrete design and is absolutely borne out by practical results.

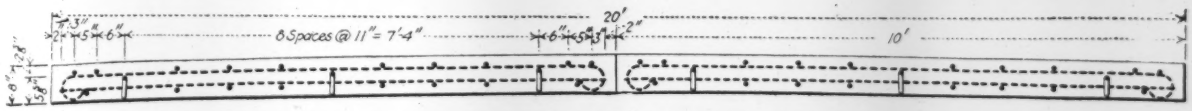
The writer has frequently heard the statement made by engineers who are in the habit of constructing concrete roads without the use of reinforcement that the roads which were reinforced cracked just as badly as those which were not reinforced. This statement is refuted by experience and all the skeptic has to do is to go and look at the roads. It is a fact, however, that some reinforced roads have cracked almost as badly as the plain concrete roads but this defect it is believed is entirely due to the design and construction.

The cracks in reinforced-concrete roads, however, where they do occur, are very characteristic. Usually a crack will be found to be nothing more than a hair line not wide enough to receive the point of a penknife. On one road inspected recently, with transverse joints 200 and 150 ft. apart, of a length of four miles, perhaps 15 or 20 transverse cracks were found. Most of these cracks did not go the entire width across the slab and none of them had opened sufficiently to permit a piece of paper to be inserted between the sections. This road was three years old and was reinforced heavily at the bottom in the longitudinal direction with a lighter reinforcement in the top. A half dozen of these transverse cracks which were examined were found to extend only part way through the slab at the edge—in other words, the bottom reinforcement had been effective in preventing the complete development of the crack. This same phenomenon has been noticed on a number of roads of this type.

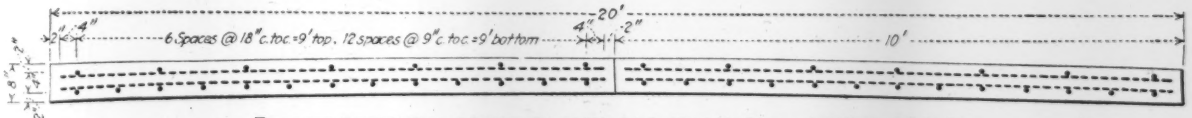
The theoretical analysis of a road slab under traffic and changing soil conditions will undoubtedly show that reinforcement should be placed in both top and bottom and in almost every portion of the slab. Following this to its logical conclusion it would therefore be necessary to reinforce both top and bottom of a slab to take care of the stresses which it must carry.

As a practical matter, however, the writer is not convinced that this is necessary in every case. Experience seems to show that top reinforcement is the most effective and in this respect I am inclined to agree with Mr. Breed. Cases have been found where the slab was cracked underneath but the crack did not come through the surface because there was sufficient reinforcement to prevent it. It is well known in laboratory tests of concrete beams and slabs that it is easy to develop a crack in one side of the beam without its becoming visible on the other side.

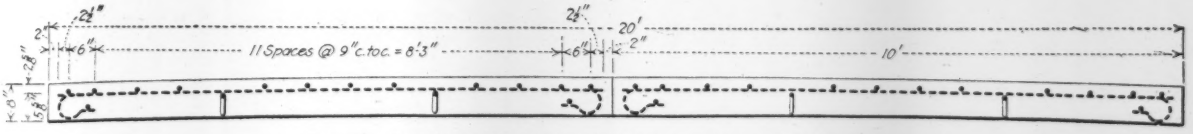
The object of reinforcing a concrete road is not necessarily to take care of all bending stresses which may develop but rather to prevent cracks forming in the surface of the road or in any portion of it, for that matter, which may require maintenance and ultimately lead to the breaking up of the slab. If this can be prevented by surface reinforcement alone, the object sought has been accomplished for the least expenditure. The best highways that we have are reinforced top and bottom but we have others which are reinforced in the top alone, with a smaller amount of steel, which are in almost equally good condition.



Transverse Bars Alternating Top and Bottom, Spaced 14 in. C. to C.; Weight in Pavement, 124 lb. per 100 Sq. Ft.



Transverse Bars Both Top and Bottom, Spaced 28 in. C. to C.; Weight in Pavement, 112 lb. per 100 Sq. Ft.



Transverse Bars Spaced 18 in. C. to C., Weight in Pavement, 92 lb. per 100 Sq. Ft.

SUCCESSFUL TYPES OF DEFORMED BAR PAVEMENT REINFORCEMENT

Borings made by the New Jersey State Highway Department through a surface crack in a road which was reinforced top and bottom, show conclusively that in many cases surface cracks do not extend clear through the slab. Levels run over the surface of a concrete road which has been constructed upon a new subgrade will show many places where portions of the slab have settled and other portions have not. This necessarily requires readjustment of the slab to the surface, and unless it is reinforced cracks are certain to develop. Even if a slab is reinforced cracks are likely to form over culverts or other rigid points unless provision has been made for this contingency by transverse joints at either side of the culvert. On one road recently inspected by the writer about two miles long, the only crack found was directly over a culvert.

Close Spacing Unnecessary—The statement is frequently made that a close spacing of bars in road reinforcement is necessary to success but to date there is no evidence that this is the case. In fact, it is hard to see why this should be so because it is never a tendency of even a plain concrete road slab to break into small pieces at first. The first cracks which form seldom divide the road into sections smaller than 3 or 4 ft. square and it is therefore hard to see how a

close spacing of reinforcement would prevent the formation of initial cracks, any better than a wider spacing would. As a matter of fact, excellent results have been secured with the spacing as wide as 30 in. center to center with an 8-in. slab.

The accurate placing and holding of reinforceemnt in its correct position during the operation of concreting are of the utmost importance and this has been proven by two or three examples of roads constructed during the last two years. One road in which a self-supporting bar reinforcement was employed shows practically no cracks while another road in which a flat mat type of reinforcement was used of practically the same amount, has shown considerable cracking.

Where mesh or flat mats of bars are employed it requires rigid inspection on the part of the engineer to secure accurate placing of the reinforcement. One method is to level the concrete off at the proper height, place the reinforcement and then pour the balance of the concrete and finish. This method has not proved satisfactory not only on account of the delay to the contractor, but because it has been conclusively shown by borings that the reinforcement is almost never where it was supposed to be even where the inspection is above reproach.

Another method is to employ movable supports which are attached to the concrete mixer which are pulled out as the machine moves ahead. This method secures a more accurate location of the reinforcement in the slab. Borings made through completed roads, however, have shown that the withdrawal of the supports leaves a permanent hole or void in the slab which is highly objectionable. It also imposes a very heavy strain on the tractor of the mixer and has caused much trouble in this respect. On engineering grounds alone this method should not be permitted and one of the first highway departments to adopt it has now abolished it for the reasons cited.

A concrete road can be built with a quite moderate amount of reinforcement but to secure this result will require a higher initial cost for joints and a higher maintenance expense with poorer riding qualities. On the other hand if the joints are placed too far apart transverse cracks will develop in the middle of the section or it will be necessary to employ a large amount of longitudinal reinforcement. In addition to this the movement at the joints is apt to be greater and there is more danger of trouble in this respect.

From the standpoint of the traveling public, the road with wide spacing rides very much better and certainly looks better. As a result of experience the writer is inclined to recommend a spacing of approximately 100 ft. between the transverse joints with 50 ft. as a minimum.

Test Results—The tests which were made at Pittsburg, Calif., are quite frequently referred to as being an indication that reinforcement in concrete roads was not successful. The writer did not have the pleasure of being present at these tests but an inspection of the sections used reveals at once that longitudinal reinforcement of any considerable amount was not employed. As a result, all of the reinforced slabs were cracked before the test began. There was no slab in the whole road that we would rate 100 per cent before any load was applied. We have found, particularly in a divided road, that longitudinal reinforcement is the most important element and had this feature been appreciated before the Pittsburg test, the result would undoubtedly have been different.

In the Bates Road tests made near Springfield, Ill., there were no heavily reinforced sections employed. Some sections were reinforced with mesh of 45 lb. weight.

In the Columbia Pike, an experimental concrete road built under the supervision of the Bureau of Public Roads near Arlington, Va., in 1921, the only sections which have not cracked transversely are those in which a heavy longitudinal reinforcement was employed. So far as known this road has not been subjected to any concentrated traffic test.

Experiments of this kind are interesting and furnish much valuable data, but should not be taken as conclusive evidence by themselves because the time which they cover is not long enough to allow the elements and seasons to have their full influence.

When frost action is severe, it will sometimes happen that one-half of a divided road will heave more than the other half and sometimes they will be at slightly different levels when the frost has left the ground. To prevent this, dowels are frequently employed across the longitudinal center joint. They should be deformed bars bonded at both ends as they will then prevent the tendency which the two slabs sometimes have to separate horizontally. When this is done, however, it is highly important that the transverse joints in the two halves of the road be either directly opposite each other or staggered only a few feet as it has been found that one slab will crack the other opposite the transverse joints when the joints are staggered and the slabs dowelled.

Transverse joints should be dowelled with bars which will allow a moderate amount of horizontal motion of the two slabs.

The transverse joint is the weakest part of a concrete road and a really satisfactory solution of this question has not yet been made. It may be possible to construct a reinforced-concrete road practically without transverse joints and either eliminate cracks by heavy longitudinal reinforcement or so distribute the cracks that they will not be larger than hair lines and will not require maintenance. There is no case on our records where this has been tried with sufficient reinforcement to prove whether this plan is feasible or not.

Results of Experience—The results of experience to date with various types of reinforced-concrete roads may be briefly summarized as follows:

1. Light reinforcement weighing less than 40 lb. per 100 sq.ft. of any type has produced very little better results that could have been expected from plain concrete.

2. Reinforcement weighing 50 to 55 lb. has produced good results with the divided type of pavement if the transverse joints were not more than 30 ft. apart and if the reinforcement was located near the top of the slab.

3. Reinforcement weighing even as much as 100 lb. per 100 sq.ft. has not produced entirely satisfactory results when located near the bottom of the slab.

4. Marginal reinforcement of any type which we have seen has not produced the results expected.

5. Ideal construction has been secured by using from 80 to 120 lb. of reinforcement in either one or two layers properly located and distributed and construc-

tion joints may be placed 100 ft. apart without danger of transverse cracking.

6. Corner breaking has been entirely eliminated by this type of reinforcement without thickened edges.

It seems, therefore, that the upkeep of a properly designed and constructed reinforced-concrete pavement may be reduced to the expense of maintaining about 50 transverse joints per mile. Just what the life of these pavements will be of course no one can say, but if a comparison made at the age of ten years may be considered as a reliable guide it seems certain that the reinforcement will often double the life of a concrete highway.

New Sanitary District of Elgin Has Large Program

Design Data, Assumptions and Estimates Used in Working Out Sewage Disposal Program Costing Three-Quarter Million

AFTER a year of intensive investigation, the Sanitary District of Elgin (Ill.) has adopted a sewage disposal plan involving a low level intercepter with four crossings under the Fox River, a pumping station and treatment with Imhoff tanks and sprinkling filters. Factors entering into the problem were population, quantity, chemical characteristics of the sewage and the capacity of the river to care for treated sewage. On the 5,320-acre area of the district is a present population of 28,260 people. The intercepter, it was felt, should be built to handle a population of 75,000 and the other structures for half that number.

TABLE I—SEWAGE GAGINGS AT ELGIN COMPARED WITH THOSE OF OTHER ILLINOIS SANITARY DISTRICTS

Gallons per Capita per Twenty-four Hours

District	Average Sewage Flow Dry Season	Wet Season	Industrial Sewage	Infiltration Gal. per Day per Acre
Elgin	88.3	165	47.5	150
Urbana-Champaign	50.0	100	....	1,200
Bloomington	84.0	167	20.0	*450
Decatur	97.0	150	24.0*	400

*Estimated by Pearse, Greeley & Hansen.

Weirs were built in six sewer outlets serving 75 per cent of the population and hourly readings were taken from June 11 to June 20, 1923. As a result of these gagings, which were compared with other Illinois sanitary districts as shown in Table I, the outlet of the intercepter was given a capacity of 18.6 m.g.d., equivalent to 250 gal. per capita per day at 75,000 population. The treatment works were planned on a basis of 88.3 gal. per capita. Studies of the industrial wastes indicated little oxygen-consuming sewage but large amounts of condenser water, about 35 per cent of the dry-weather flow.

From composite samples, there was found 296 p.p.m. suspended matter, 149 p.p.m. oxygen consumed, 29 p.p.m. organic nitrogen and a strong alkaline reaction.

Based on gagings of the U.S.G.S. and on records from certain power plants, a minimum river flow of 50 sec.-ft. from the 1,520-sq.mi. drainage area was estimated with a flow less than 150 sec.-ft. persisting for about 3 per cent of the time and a flow of 300 sec.-ft. or less for 21 per cent of the time. Dissolved oxygen determinations of river water indicated a relatively ow content reaching 50 per cent saturation just above Elgin. As a result of these studies it was estimated that there would be insufficient flow to properly care for the effluent from settling tanks for about one-fourth of the time. The extent of treatment required at Elgin to prevent river pollution was, then, important

The gagings indicated periods of several weeks' duration nearly every year when partial treatment would be insufficient and it was considered that at other times the effluent after sedimentation might not entirely relieve the river of objectionable characteristics such as discoloration, oiliness, some sludge deposits and the like. On the other hand it was considered that the installation of complete treatment works at Elgin would be a step somewhat beyond that of other communities along the river. Nevertheless, it was thought best to adopt a program calling for the installation of complete treatment works and to arrange for the financing of the construction as rapidly as possible.

TABLE II—ESTIMATED COSTS OF SEWAGE TREATMENT AT ELGIN

By Different Processes

Process	First Cost	Possible Revenue from Sludge per Year	Net Annual Cost Including Fixed Charges 12 Months Operation	4 Months Operation
Sprinkling filter				
Complete plant	$457,900	None	$47,300	$45,600
Activated sludge				
Complete plant	367,000	$12,070	58,030	42,030
Sludge lagooned	316,600	None	58,845	39,945

Comparative estimates were made for treatment works comprising the activated-sludge process and Imhoff tanks with sprinkling filters. The activated-sludge plant was based on 6.5 hours displacement period with 1.25 ft. of air per gallon of sewage for average conditions. Imhoff tanks were proposed with three hours displacement period and 2.25 cu.ft. per capita of sludge storage capacity. Sludge drying beds were included at the rate of 0.67 sq.ft. per capita and sprinkling filters for 18,750 people per acre of filter 6 ft. deep. Numerous projects were worked out for different amounts of treatment, different methods of handling sludge and for complete treatment during 4 months and also during twelve months of the year.

On the basis of twelve months operation the total annual cost, including an allowance of 7.5 per cent for interest and bond retirement, the sprinkling filter project is the less costly. On the basis of four months operation and allowing a credit for the sale of sludge at the rate of $12,070 per year the activated-sludge process was less costly by $3,500. Although the choice between the activated-sludge process and the sprinkling-filter process of Elgin was close, the uncertainty of securing a sludge revenue and of reducing operation to only 4 months a year indicated the sprinkling-filter plant as the safest and most conservative procedure.

TABLE III—COMPARATIVE PER CAPITA CONSTRUCTION COSTS OF SEWAGE-WORKS

Sanitary District	Per Capita Construction Cost	Remarks
Decatur	$27.90	Under construction
Urbana-Champaign	20.70	Under construction
Downers Grove	26.00	In operation
Elgin	25.90	....

The per capita costs of several projects for other sanitary districts in Illinois are shown in Table III.

These costs are figured against the present population of the sanitary districts, although the works are built for future populations. The lower cost at Urbana-Champaign results from less difficult intercepting sewer construction.

M. H. Brightman is engineer for the Elgin district and Pearse, Greeley & Hansen are consulting engineers. On Jan. 26 a bond issue election was held.

General Contractors Discuss Construction Business

Bonding Practices Criticized—Training of Apprentices Advocated—Year Around Construction Operations Urged—Contract Standardization Advanced—War Contract Suits Reviewed

Engineering News-Record Staff Report

CONTRACTING business practices and construction methods occupied about equal attention in the committee reports and special papers read and discussed at the annual convention in Chicago, Jan. 21-24, 1924, of the Associated General Contractors. While the four-days' proceedings were long and rather crowded, virtually the entire program was completed. Functioning largely through committees the association in convention has a minimum of business details to consider and its action on elections, budget, resolutions and staff officers' reports is usually prompt and definite. Business action at Chicago, therefore, consisted of little more than a rapid confirmative vote on the committee reports. This procedure allowed nearly all the time of the eight sessions to be given to the professional reports and addresses. These were generally of high character and those on the more live questions of bonding, labor supply and construction methods were actively discussed.

On recommendation of the committee report, the budget for 1924 was set at $115,000 with instructions that expenditures under no conditions were to exceed the receipts and that of receipts exceeding the budget total up to $10,000 be set aside as a sinking fund to repay the debt of the association. The report of the tellers showed the election of the regular ticket in full, with F. L. Cranford of Brooklyn, N. Y., as president and A. S. Downey of Seattle, Wash., as vice-president-at-large. Besides the resolutions which are mentioned in connection with the reports and discussions which follow, a resolution was passed supporting a federal contract law, and another advocating the enactment of the Mellon tax-reform plan without modification, a third advocating a federal board of public works and a fourth recommending no change in federal railway legislation.

Labor Shortage and Suggested Remedies—Except contract bonding practices, labor supply and methods of improving it were the subjects most actively discussed. In its report the committee on labor, Leonard C. Wasson, chairman, announced that a special census of contractors employing 32,000 workmen, showed, in June, 1923, a shortage of 9,800 or of 31 per cent. The range of shortage ran from 3 per cent for enginemen to 54 per cent for plasterers and 57 per cent for lathers. The report set forth as remedial measures: (1) Accretions by immigration, (2) the training of apprentices, and (3) the extending of building operations more generally throughout the twelve months of the year. Most attention, the committee stated, had this year been given to the subject of apprentices in the building trades. An outline for apprenticeship schooling of rather elaborate character covering four years' time had been outlined. The committee urged at length that apprenticeship practice should not be considered as an emergency task but on the basis of a broad-gage, permanent solution for all times and that contractors should actively co-operate by advancing the idea and by employing apprentices as they offer themselves.

A difference of opinion on the committee report developed quickly in the active dicussion which followed and which lasted beyond the regular time allotted and was continued in an extra session held after the regular sessions were completed. In this discussion one side took the position that what contractors wanted was not a broad plan of educating apprentices, but an emergency method of getting skilled workmen quickly by rapidly developing ordinary workmen into skilled men by short training courses. It was urged that the source of supply should not be boys induced to take up a building trade, but men already in construction work as laborers or the other more menial occupations. The other side, supporting the committee report, argued for complete training of two or four years in apprentice schools. Its speakers contended that the industry needed most not men trained in the trades just well enough to "get by," but skilled mechanics trained collaterally in citizenship and having pride in their vocation.

A special plea for a well-planned and long-time apprenticeship schooling was made by John W. Cowper, who outlined at length the action being taken along fundamental lines by the American Construction Council and urged the support of contractors for the council's broad-gage consideration of the subject. In a brief address E. J. Mehren outlined the effective work for apprentice training which is being carried on by the New York Building Congress. He laid stress on the fact that it was not the labor unions which were hampering the development of apprentices but rather the contractors who refused to employ them and who by their seasonal employment discouraged boys from taking up a vocation that offered them only part-time employment. As action on the discussion, a resolution was passed committing the association to the support of every effort for the development of apprenticeship in construction.

Contract Bonding Practice Criticized—It was disclosed in the report of the committee on insurance and bonds that discontent with bonding practices was most acute in highway construction. Expressions received from some 30 highway departments indicated that difficulties were widespread and that they were causing not only considerable disruption to highway programs but also much unnecessary expense. The intensity of feeling among highway engineers concerning present bonding practices varied from indifference in some of the New England states to a feeling in some of the western states that insofar as construction was concerned the bonding companies had about served their usefulness to the public. In conclusion the committee stated: "It is not the intention to launch an attack upon the bonding companies, nor to disparage the integrity of reputable bonding company officials, but it is intended to call attention to certain facts that can no longer be denied; a condition has been created which, though now reacting detrimentally, principally to contractors and the public at large, will eventually react against the most responsible of the bonding companies."

Commenting separately on bonding practice the committee acting jointly with a committee of the Association of State Highway Officials stated that: "If the

surety companies cannot devise a means of eliminating detrimental practices on the part of agents, and of faithfully performing their stewardship to the state, the force of public opinion will eventually demand that their house be placed in order. Therefore it is proposed that before present conditions become more aggravated, representative bonding officials be invited to meet with representatives of the Associated General Contractors and of the Association of State Highway Officials to devise, if possible, an amicable and co-operative method of relieving the present situation."

Discussion of these reports was conducted in executive session and may not be reported but the conclusions were formulated in a resolution authorizing the A.G.C. committee to take part in the general conference of the A.S.H.O. committee and a committee of the surety bonding companies, to consider the whole question of contract bonding practice.

Contracts and Contracting Methods—Perhaps the most constructive work in contract practice reform, announced at the convention, was that reported by the joint conference on standard contracts composed of nine engineering, architectural and contracting associations. Agreement has been reached on a draft of general conditions, and also on special conditions for building work and railroad work, which make two complete tentative documents developed. Other documents are contemplated and can soon be completed as the agreements already reached settle the great body of contracting principles concerned with construction. Besides this specific task of the committee on contracts, report was made of the tentative contract drafted by the Interdepartmental Board of Contracts and Adjustments and the complimentary task of preparing a general federal contract law and the support of the association in these reforms was urged.

Chief interest was aroused by the address of Arthur S. Bent on day labor construction. The condemnation of this practice was general in the discussion which followed and it was urged that general action be taken to secure laws requiring communities which do public work by day labor to keep and make public a full cost accounting for every operation. In the rather hot criticism of day labor development the charge was made that the cost-plus contract promoted by many firms had largely encouraged and supported advocates of day labor construction. A strong denial was made by those practicing cost-plus work and the general trend of opinion appeared to be that both forms of contracting had their place and could be practiced to advantage. As a conclusion of the day-labor question the resolution committee brought in a resolution condemning the drift toward day labor for general public works construction and advocating laws calling for a full accounting on all work so performed.

Construction Methods and Practices—A report of great length and touching a variety of subjects was presented by the committee on methods. Lengthening the construction season was strongly urged. Regarding its economic aspects the report stated: "Winter work is not recommended as economical or desirable in every specific case, but it is believed that, in general, completion of work six months in advance of present practice, the reduction of lost time due to waiting for materials, the ability to purchase materials in duller markets, reduction of overhead, increased efficiency of workmen and elimination of labor bonuses will more than justify the somewhat increased field cost of executing work in cold weather."

Approval is given to quantity surveys. The committee, however, believes that the bureaus should be self-sustaining, but not profit making, and that care should be exercised to see that the bureau methods are properly explained to the local engineers and architects. In concluding, the committee recommends "that representatives of the various local survey bureaus be called together by the A.G.C., as soon as practicable, in order to standardize not only the best practice and procedure for the operation of bureaus, but also to standardize sheets and units for take-off of quantities."

Standardization of materials, the committee urges, should proceed. Here, it may be interjected, the convention by resolution authorized that steps be taken to establish means by which the A.G.C. shall undertake direction of the development with manufacturers of ways of equipment standardization.

Safety practices and policies, referred to briefly in the methods committee report, were discussed at length by the chairman of the methods committee in a separate committee report on safety policy. An unusually useful summary of safety codes was given in this report, and was followed by a statement of possible policies by the A.G.C. and the conclusion that it should work for: (1) The adoption of a national safety code, (2) the unification of vital accident statistics, (3) co-operation with the National Safety Council, (4) co-ordination with national insurance agencies in revision of specifications and practices, (5) study of safety policies, (6) organization of local councils, and (7) selection of inspectors by civil service rules.

Recommended Legislation—Little action was taken last year on proposed laws affecting contractors. Among the laws recommended are laws providing for continued federal aid for roads, for the relief of navy contractors, for cost accounting on day labor construction, for the use of negotiable securities in lieu of bonds and for several state enabling-acts providing for adjustment of compensation, retained percentages, payment for materials and for arbitration.

War Contract Suits—After all the months of investigation and study devoted to the indictments of the war contractors, it was reported by R. C. Marshall, Jr., general manager, A.G.C., "nothing but inadmissible generalities have resulted and nothing of a criminal nature has developed." The contractors who have been sued entered motions in the courts of jurisdiction, requesting that the Department of Justice supply a bill of particulars which would designate the items for which they were being sued. The answer stated that these contractors were not sued for a detailed accounting but rather because their conduct had been improper. The courts have not accepted this answer and have called for a bill of particulars. In reply the Department of Justice has presented a statement in very general terms lumping together into groups its charges of wrongdoing. To these groups it has assigned monetary values. Action has not been taken by the courts. General Marshall stated: "There appears to be good reason to believe that the cases will be thrown out of court on the decision of the judge that the Department's contentions are lacking in genuineness and that substance for suit is wholly lacking."

Operating Headquarters of the Philadelphia Water-Works

Division Offices, Repair Shop, Storage Sheds, Garage, Stable and Pipe Yard Gathered at Central Point

By Seth M. Van Loan
Deputy Chief, Bureau of Water, Philadelphia, Pa.

PHILADELPHIA has established operating headquarters for its water-works where division heads have daily contact and profit through that co-ordination which is invaluable for any large industrial plant where overlapping of responsibilities often requires adjustment. Besides this co-ordination such a central operating point facilitates a constant supervision over shop repairs and portable equipment, an economic draft on general stores, accessibility to plans of design and plant operation, open to all progressive employees.

A plot of ground acquired by the Bureau of Water at an early period for a reservoir site was taken for the purpose just indicated. The site is readily accessible from the city center and outlying stations.

The arrangement of the plant is shown by Fig. 1. Each unit is designed to guarantee ample space for the natural growth and development of future years. The essential units are a repair shop, headquarters building, sheds for stores and equipment, garage, stable, pipe yard.

Repair Shop—In *Engineering News-Record*, May 11, 1922, p. 772, appears a description of the repair shop (Fig. 2) herewith.

Headquarters Building—General offices of the division head, a meter shop and a large drafting room are located in the headquarters building (Fig. 3). The building harmonizes in outside features with the repair shop. The wide paved court separating these two buildings affords space for the parking of cars of operators or visitors during the active hours. Near the general office entrance is located a telephone-switchboard where message relays are made to twenty local instruments. Wood block provides a noiseless and satisfactory floor covering. The building is warmed by steam. Light and ventilation are abundant and suitable rooms for lockers, washroom and shower bath are provided.

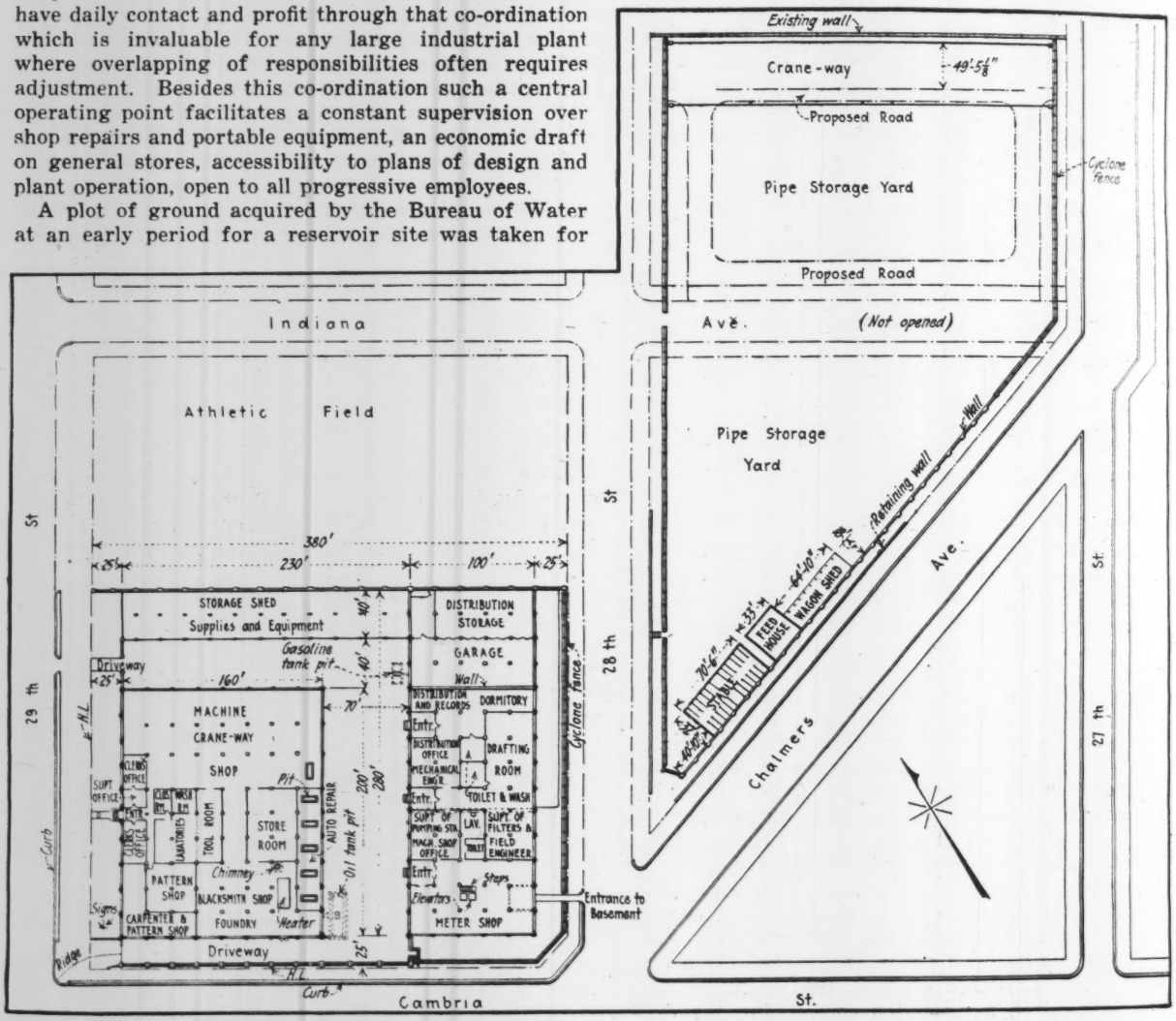


FIG. 1—GENERAL LAYOUT OF OPERATING HEADQUARTERS OF THE PHILADELPHIA WATER-WORKS

The work of this branch of the service for the entire city is here planned and routed, all activities being advertised on route boards which hang in a convenient and conspicuous place on the wall. These route boards have placed on them in order, the work in progress, the work planned for the next day, and work for future attention. One line on the board is assigned to each gang, and the cards are moved over to new position as the work involved changes in status, thus giving an up-to-the-minute record at all times.

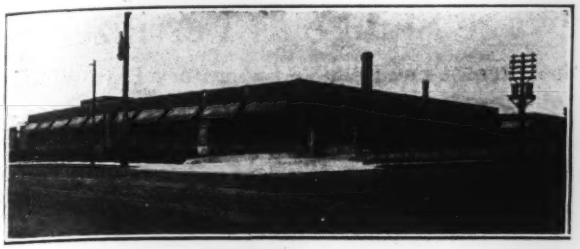


FIG. 2—FRONT AND SIDE VIEW OF REPAIR SHOP

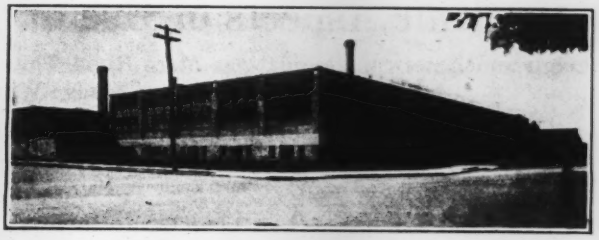


FIG. 3—SIDE AND REAR OF HEADQUARTERS BUILDING

A night force is housed in a dormitory adjacent to this office, the men being uniformed and prepared to meet emergency calls at night, Sundays or holidays.

Meter Shop—The meter shop has a three-side exposure which gives favorable conditions to the workmen. A general view of a testing bench with near-by rack is shown by Fig. 4. The shop route of a meter follows in general a circle. Tables for inspection or examination, a cleaning tub, repair benches, large and small test tables and storage racks are so placed as to afford sequential work and minimum handling. Suitable bins and cases are installed for repair parts, all of which are issued by system from a standard stock. The basement of this building offers space for crated meters, a storeroom for Water Bureau records, a rigging loft and the heating plant. Meters are brought in and placed on receiving racks, from which they go to dismantling benches and are opened and note made of defective parts. The meter frame, loose pieces, and the record tag are then placed in a box to go to the assembling and testing benches. The boxes are of uniform size. Handling the dismantled meter in this way instead of reassembling it saves considerable time. Assembled and tested meters are kept on separate racks from which they are checked out as required. A meter record tag of uniform kind remains with every meter from the time it leaves the consumer until it is repaired

FIG. 4—METER TESTING BENCH AND NEARBY RACK

and tested ready for use again. Each part of the meter is checked against this tag and repairs and replacements noted.

Sheds—The sheds for stores and equipment are eleven in number and to each is assigned a classified stores. Here under the control of a storekeeper are housed in order: Paints, oils and lubricants; chemicals, oxygen and acetylene gas; pipe covering cement and fire brick; lumber; miscellaneous large stores, as shovels, wheelbarrows, buckets, etc.; wiping rags and waste in bales; machinery and equipment held for shop attention; heavy steel, boiler and stoker parts; light flat and round iron and steel on racks; wrought and brass pipe and boiler tubes; small fittings; metal pigs,

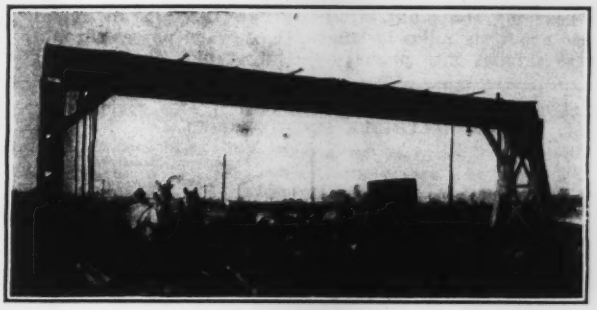


FIG. 5—TRAVELING CRANE OF 50-FT. SPAN IN PIPE YARD OF PHILADELPHIA WATER-WORKS

packing, etc. Reserved for portable equipment are two sheds in which are placed pumps, compressors, cement gun, concrete mixers, emergency wagon, etc.

Garage—A well lighted and heated garage provides storage room for service cars. A check account for consumption of oil, gas and tires is kept for each car, the repairs being handled in the motor repair division of the repair shop, located across the court.

Stable—The Bureau has only twenty horses, which are kept for various kinds of work. Replacement by motor vehicles of the horse-drawn wagon and truck is favored, and cars with trailers are gradually being substituted (see *Engineering News-Record*, May 17, 1923, p. 885).

Pipe Yard—On account of the proximity of the city to iron pipe manufacturers, it is not essential to store all sizes of pipe in quantity, yet it is expedient to hold a sufficient stock for building operations and for emergency call. Special castings and valves are kept in limited quantities and to possess a generous stock of lesser size castings—valves, fire hydrants and stop box frames with covers—is economical.

The pipe yard at one end is equipped with an electrically operated traveling crane (under construction) having a 50-ft. span. Under this crane way, reserving space for a roadway, are stored heavy castings and the larger valves. Fig. 5 shows how adaptable this type of crane may be for quick and economical handling of material. Scrap iron is stored in this yard until enough has been accumulated to be sold.

Hygienic Aspects of Use of Sewage Sludge as Fertilizer

Foreign and American Regulations More Rigid Than Most Recent and Reliable Laboratory Data Which Indicate that Well-Digested Sludge Will Not Cause Vegetable-Borne Disease

Special Report to the State Board of Health of Maryland

By Abel Wolman
Chief Engineer, Maryland State Department of Health, Baltimore, Md.

AT THE meeting of the State Board of Health on Jan. 19, 1922, the problem of the disposal of wet sludge at the sewage treatment plant of Baltimore at Back River was discussed. During the latter part of 1921, the authorities in charge of the Baltimore city sewage treatment plant requested permission from the State Department of Health to sell the wet sewage sludge, which had been digested in the sludge tanks, to farmers in the vicinity of the plant to be used for fertilizing crops. This report has been prepared in accordance with the request of the State Board of Health, in order to set forth briefly the conclusions which have been reached in this question.

In order to understand fully the nature of the problem, it is well to outline in passing the form of treatment to which the sewage of Baltimore is subjected at Back River. On reaching the plant, after its flow through an outfall sewer about six miles in length, the sewage passes through coarse screens into primary settling tanks, onto trickling filters and finally through secondary settling tanks. The sludge from the primary settling tanks is drawn off into separate sludge digestion tanks where it is usually held for at least several weeks for complete digestion. It is this digested wet sludge which the authorities of the city contemplate selling to the neighboring farmers for use on the fields. It had been the practice of the superintendent of the plant to furnish this material some years ago to the farmers, but this plan was discontinued until the recent request for resumption of this program was presented to the board. As a matter of record, the figures given in Table I are reported to indicate the sludge disposal problem with which the city is annually confronted.

TABLE I—DIGESTED SLUDGE PRODUCTION AND DISPOSAL AT BALTIMORE SEWAGE-WORKS

Year	Flow M.G. per Year	Cubic Yards of Digested Sludge (90 per cent Moisture) Produced	Disposed	In Tanks at End of Year
1912	4,321	6,568	No Record	No Record
1913	6,597	11,348	No Record	No Record
1914	8,372	32,233	24,981	15,168
1915	11,607	47,010	49,856	12,322
1916	14,374	53,040	45,760	19,602
1917	16,200	51,029	29,616	41,015
1918	19,285	64,025	39,103	65,937
1919	20,096	59,886	65,617	60,206
1920	19,074	57,223	57,214	60,215
1921	17,016	52,375	72,072	40,518
1922	17,336	61,796	63,180	39,134

It might be well to point out in advance that it is my plan to discuss herein only those aspects of the sewage sludge problem which have a hygienic implication. In the particular problem at hand, the economic value of such material as a fertilizer is not discussed. Whether the sewage sludge may or may not be disposed of at profit by the city authorities is of no concern in the determination of the safety or danger of the use of such sludge from a public health standpoint. In the preparation of this discussion and in the attempt to arrive at definite and valuable conclusions several methods of attack upon the problem were investigated. Some of these will be discussed in considerable detail below, while others, which I shall point out, have been left for consideration by Dr. Collinson for further study and report. This plan is the result of agreement with Dr. Collinson.

A. Epidemiological History of the Use of Sewage Sludge and Liquid Sewage on Sewage Farms—The discussion of the epidemics which have been associated supposedly with the use of various forms of sewage as fertilizer is part of the subject matter which was not to be considered in detail in this particular report. It is advantageous, however, to point out that, although a number of reports have been presented in past years dealing with the supposed dissemination of typhoid and paratyphoid fever and dysentery by vegetables contaminated by liquid sewage or sludge, few of these reports have been presented in recent years since the important rôle of the food handler as typhoid carrier has been realized and emphasized. In discussing the histories of these various epidemics, it may be suggested that relatively few of them, supposedly attributed to the use of sewage fertilizer, may have really had their origin in this direction, but were probably caused by the handling of foods by typhoid carriers in the kitchen. It is impossible, unfortunately, to analyze the data of such outbreaks as were reported by Warry, Morse and others, at least ten years ago and in some instances more than twenty years ago. In the absence of the detailed case and other records of such epidemics, we are safe at least in assuming that more definite information is necessary to confirm these earlier findings than has been accumulated within the last decade. These brief comments on existing epidemiological data are inserted here in order to make clear that experimental data on typhoid fever bacillus longevity in digested sewage sludge must ultimately supply the answer to the problem of safe use of such material on various crops. The further discussion of this particular phase of our subject is in the hands of Dr. Collinson.

B. Current Practice and Regulations for the Application of Sewage Sludge and Liquid Sewage in Farming—It is always advantageous, in searching for a solution to a difficulty, to draw upon the experience and practices of other agencies. With this fact in mind, it appeared to me that the State Board of Health would be interested in having some comment upon the current practice of various organized bodies which have to do with the control of the application of sewage compounds to farming. During the past year it has been possible to accumulate a considerable record of information pertaining to this subject by extensive correspondence with various agencies in this country and abroad. The material which I am submitting to you for consideration represents, therefore, the practice and regulations which were in current usage at as late a year as 1922. For convenience of reference the details of the information so collected have been tabulated and subdivided in Tables II, III and IV, attached to this report. The subject matter included under the head of control of disposal of sludge may be profitably divided into the practice in foreign countries and in the United States.

a. Foreign Practice—In Table II there is presented in as brief a form as possible the information regarding the use of sewage or sewage sludge in certain foreign areas, where such material has been employed as a fertilizer for many years. It will be noted from these data that a number of cities have been included which are using sludge which has been subjected to some treatment for drying and for sterilization. These cases have been noted in the tabulation and are included therein only for purposes of permanent record. The problem of the application of dried and sterilized sludge has by no means the same significance as that which confronts the city of Baltimore. There are, however, a number of cities listed in Table II which apply settled sewage and wet sludge to fields for the growing of crops.

It is interesting to note, for example, that in the city of Paris, where settled sludge has been used for a number of years for irrigation and fertilizer purposes, the use of such sewage is forbidden on areas where vegetables or fruits which are to be eaten raw are produced. Since the city of Paris controls the distribution of such sewage, its author-

ities have formulated a contract with the farmers, and wherever the above regulation is not complied with, it is possible for the city to terminate the contract. I am informed by the administrative director of Public Works of Paris that no procedure for the enforcement of this regulation is necessary because of the primary control of the sources of material which lies in the hands of the city itself.

The Ministry of Health of England has been kind enough to supply me with a general statement of its practice with reference to the control of these problems in England. As will be noted from the statement in Table II, the Ministry of Health has not found it necessary to formulate definite restrictions, but it is assumed that sewage in any form should not come in contact with growing crops that may be consumed without cooking.

TABLE II—USE OF SEWAGE OR SEWAGE SLUDGE AS FERTILIZER: FOREIGN PRACTICE

Community	Nature of Sewage Compound	Character of Crops	Supervision of Use	Regulations for for Use	Enforcement of Regulations
Bradford, England	Filter-pressed cake	No restrictions	None	None	.....
Huddersfield, England	Dried and degreased sewage sludge	No restrictions. Sterilized by treatment	None	None	.....
Leeds, England	Pressed sludge cake	No restrictions	On farms owned by city. Also sell to private persons	.....	.....
Manchester, England	Small amount of sludge and washings from bacteria bed dried and powdered	No restrictions	None	None	.....
Morley, England	Dried and degreased sewage sludge	No restrictions. Sterilized by treatment	None	None	.....
Wimbledon, England	Settled sewage. Pressed sludge	No restrictions. Vegetable crops (fresh and for cooking), Italian rye grass	Under direction of engineer	Sludge sold to contractor	Contract must be satisfactory to engineer
Ministry of Health, England. Summary of General Practice, April, 1922	Raw liquid, settled sewage, wet sludge, dried sludge	No restrictions formulated by Ministry of Health, but it may be taken as a general rule that in cases in which the sewage comes in contact with the growing crops they are never consumed without cooking	In the great majority of cases the distribution of the sewage is undertaken by the local authority	No regulations generally formulated	.....
Paris, France	Settled sewage	Vegetable crops (for cooking only). Vegetables or fruits to be eaten raw are forbidden	Farmers provide for distribution, while city rents some land (about ¼ of total acreage)	Yes	Generally observed, not enforced

In reviewing the practice in foreign countries, it is evident that there is general agreement of opinion that it is unwise to permit the application of wet sludge to food products which are to be eaten raw. It must be confessed, however, that in few instances in recent literature has much experimental evidence been found which would support fully the justice of such regulations as noted above. The practice in these areas, as well as in certain sections of the United States, appears to have been formulated upon the basis of experimental investigations which were made many years before the differentiation of pathogenic organisms had reached the present degree of accuracy. The recent experimental data, which will be presented later in this report, would appear to controvert somewhat the principles of the regulations which are now in operation.

As a matter of fact it is interesting to note that there is still little information available, in those countries where sewage sludge in the form of night soil has been used most extensively for many years, as to the life and fate of the common pathogens in sewage which has been stored for more than a few days. Even in China, where night soil is universally applied to the soil, the answers to the questions raised above are not yet at hand. The same lack of definite information is apparent with reference to the effect of storage of sewage and sludge upon various helminths, such as hookworm larvae.

I regret to state that it was impossible for me to accumulate any data in connection with the current practice in disposal of wet sludge in Germany. I am informed, however, through intermediate channels, that wet sludge is used commonly in various parts of Germany without any restrictions as to the nature of crops grown.

b. American Practice: Municipal — There are a number of cities in this country which dispose of their sewage, either as raw or settled sewage, or wet or dried sludge, by application to farms. By no means a complete list of these is presented in Table III. In most of these cases it is also found that a general feeling persists that it is unwise and dangerous to the public health to permit the application of materials of human sewage origin to root crops or food products which are to be consumed in the raw state. This principle is carried further in the case of Santa Rosa, Calif., where no milk cows are permitted to pasture on sewage irrigated fields, although horses, dry cattle and hogs are sometimes permitted thereon. In several of the cities listed in Table III the restrictions above noted are easily enforced through the fact that the city owns the land under cultivation or else controls its usage by lease or contract.

TABLE III—USE OF SEWAGE OR SEWAGE SLUDGE AS FERTILIZER:
A. AMERICAN PRACTICE—MUNICIPALITY

Community	Nature of Sewage Compound	Character of Crops	Supervision of Use	Regulations for Use	Enforcement of Regulations
Atlanta, Ga.	Air-dried sludge	Corn, cotton, etc.	None	None	.....
Canton, Ohio	Wet sludge, dried sludge	General farm crops	None	None	.....
Fitchburg, Mass.	Air-dried sludge	Mostly grass land	None	None	.....
Fresno, Calif.	Settled sewage	Alfalfa, corn and grass for pasturage	City-owned land	State regulations	.....
Hastings, Neb.	Raw sewage in ponds	.....	City-owned	.....	.....
Jefferson County, Ala.	Dried sludge	No restrictions	Sludge given to any person who will haul it	None	.....
Mansfield, Ohio	Dried sludge	Everything excepting root crops	None	None	.....
Pasadena, Calif.	Settled sewage. Dried sludge. Wet sludge, at times	Walnuts, oranges, alfalfa, corn, potatoes	City farm leased to private person	State regulations	.....
Pomona, Calif.	Raw sewage	Walnuts, corn. No crops irrigated which grow below ground	Sewage used on city-owned farm, about 8 miles from city	State regulations	.....
Pontiac, Mich.	Dried sludge mixed with lime. Stored about 4 months before use	Minor usage	None	None	.....
Salt Lake City, Utah	Raw sewage	Ordinary farm crops—hay and grain, no vegetables	Contract with city	Supervised by city	.....
Santa Rosa, Calif.	Settled sewage	Corn, potatoes, alfalfa, no uncooked crops*	Under control of city	State regulations	.....

* Horses and dry cattle are pastured, no milk cows. Some hog-raising.

c. American Practice: State Control—In the state of California the use of sewage material by individual cities for

fertilizer is under rigid state regulation. During 1922 inquiry was directed to all the state boards of health in the United States with reference to their practice in the supervision of the use of sewage as fertilizer. Very few of the states replying to this inquiry had formulated any regulations. By far the greater percentage of the official agencies of these states either had had no occasion to take the problem under advisement or had decided to formulate no rigid regulations. In Table IV a summary of the findings in this questionnaire is submitted.

In those states where regulations have been formulated, it has been assumed that fresh vegetables and other food products to be supplied to the consumer for use without cooking should not be fertilized with any form of wet sewage or sludge.

The detailed regulations of the State of California are of particular interest in this connection, since it is in this state that the practice of sewage irrigation has probably had its widest application in this country. These regulations are reproduced here in full, in order that they may be available to you for special review and discussion, as contained in a circular sent out by the California State Board of Health:

Circular to All Cities, Counties and State Institutions
SUBJECT—Regulations governing use of sewage for irrigation purposes

April 17, 1918.

Gentlemen:

This circular is issued to supersede circular on same subject sent you March 14, 1918, to acquaint you with certain revisions in the regulations adopted by the State Board of Health at its meeting on April 6, 1918:

Under revised ruling, it is possible to utilize sewage to irrigate farm products consumed only in the cooked state by human beings, provided the sewage be not applied to the crop for a period of one or more months prior to harvesting, and to irrigate products intended solely for canning, by special consent of the State Board of Health.

For the sake of a clearer statement of the intentions, the Regulations of Aug. 3, 1916, were withdrawn and the following substituted:

Resolved, that the following regulations governing the use of raw sewage, septic or Imhoff tank effluents or similar sewage or water polluted by such sewages for the irrigation of garden truck, berries, fruit trees, and stock feed, be adopted:

Rule 1. Raw sewage, septic or Imhoff tank effluents, or similar sewages, or water polluted by such sewage shall, under no circumstances, be used to water garden truck or berries intended to be eaten raw by human beings, e.g., tomatoes, celery, lettuce.

Rule 2. Garden truck used or intended to be used for human consumption in the cooked state may be watered with sewage, provided that no sewage shall be applied to the soil or vegetable for at least one month prior to harvesting and consumption of the product. Such crops are green corn, cabbage, cauliflower, chili peppers, pimentoes, asparagus.

Exception: By special permit from the State Board of Health, fruits and vegetables included in Rule 1 and Rule 2 may be irrigated with sewage when said products are used exclusively for commercial canning purposes.

Rule 3. Vegetables harvested exclusively in the dry state may be watered with sewage; such crops are beans, late potatoes.

Rule 4. Trees bearing fruits or nuts may be watered with sewage. Provided, however, that windfalls and fruit lying on the ground shall not be used for human consumption.

Rule 5. Cantaloupe, watermelons and cucumbers may be irrigated with sewage, provided that the sewage be not allowed to come in contact with the vine or product.

Rule 6. Stock foods, such as alfalfa, fodder corn and cow beets, may be watered with sewage, provided that milk cows be not pastured on lands while moist with sewage.

In regulating the use of sewage as above, the Board takes into account the following facts:

1. Sewage or sewage tank effluents may at any time contain the germs of typhoid, diarrhea or intestinal disease, which may be carried by berries or vegetables previously in contact with the sewage or sewage contaminated crops, and thus enter the human system.

2. Crops eaten raw, or food products may become contaminated in markets, vegetable wagons, in the kitchen, etc., if allowed to come in contact with crops contaminated with sewage which may themselves be intended only to be served cooked.

3. In the course of about one month after application, disease organisms in sewage nearly all die out and sewage deposits become quite harmless.

4. Disease organisms in sewage need moisture to live, and will die in dry ground or on crops when harvested in the dry state.

5. Cooking at boiling temperatures sterilizes sewage contaminated products. Crops intended only for canning or preserving but not for raw consumption may be safely watered with sewage (see Regulations).

6. Sub-irrigation is only partially dependable in removing danger from contamination by sewage and must be augmented by considerations 3, 4 or 5.

7. Contamination of fruits and nuts on trees above ground is impossible. Windfalls and fruit gathered on the ground are dangerous if the soil is moist with sewage.

8. Animals are not subject to human intestinal diseases, therefore sewage can be used on fodder crops.

9. Likewise, human beings are only remotely subject to intestinal animal diseases and crops fertilized with animal manure are not a menace to human health.

10. Typhoid develops rapidly in milk. Therefore milk taken from cows pastured on sewage-irrigated lands while moist with sewage is dangerous.

CALIFORNIA STATE BOARD OF HEALTH
Sacramento, Calif.

C. The Viability of Typhoid, Paratyphoid, Cholera and Other Pathogenic Organisms in Wet Sewage Sludge—The only significant index of the danger of the application of wet sludge to the soil for the growth of crops must lie in the experimental evidence which is available, or which may be developed, to indicate with some degree of accuracy what the course of life of various pathogenic organisms is when subjected to the conditions which exist in a sewage sludge digestion tank. In such a tank there must necessarily be a continual struggle for existence between antagonistic forms of life of varying degrees of strength and adaptability. In such a world of continual conflict, past experience with bacterial life has demonstrated that certain weaker forms of organized activity gradually succumb to the attacking forces of more viable organisms. It is in the study of the mortality data of such worlds as these that the foundation of regulation or restriction of use of sewage sludge for fertilizer must be found.

Unfortunately in this instance again the literature dealing with the viability of typhoid fever bacilli and similar organisms in sewage is extensive but not altogether in complete agreement. Prof. C. W. Stiles of the Hygienic Laboratory of the U. S. Public Health Service has kindly supplied me with a very complete bibliography of experimental work upon the life of typhoid fever in sewage and in soil. This bibliography covers almost ninety references. As a result of the experiments noted in this bibliography, it is reported that bacillus typhosus has been recovered in varying forms of human sewage in anywhere from 6 hours to 365 days, and in various characters of soil in anywhere from several to 540 days. It is pertinent to comment upon these findings that all of the studies which report a survival of typhoid bacillus of more than one week were car-

TABLE IV—USE OF SEWAGE OR SEWAGE SLUDGE AS FERTILIZER
B. AMERICAN PRACTICE—STATE

State	Regulations
Washington	The contents of privies, cesspools or other receptacles for human excrement shall not be used on ground within the limits of the state of Washington unless subjected to treatment by a method approved by the State Department of Health, and in accordance with the regulations of the State Board of Health. Rules and Regulations, Adopted July 27, 1921, Vol. I, p. 51.
Montana	Sale of sewage irrigated vegetables prohibited. Since the use of vegetables from sewage irrigated farms may be a factor in the transmission of typhoid fever, the sale of all vegetables grown on farms irrigated with human sewage is prohibited. Special Bulletin 21, May 1920, p. 53, Rule V.
Michigan	No regulations. We advise that sewage irrigation be restricted to the raising of stock feed and advise against the use of sludge for fertilising vegetables. Letter, E. D. Rich, State Sanitary Engineer, Feb. 6, 1922.
California	Regulations in effect—see text of report.

The following states had formulated no regulations by 1922: Alabama, Arizona, Colorado, Connecticut, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Massachusetts, Minnesota, Mississippi, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Virginia Vermont, West Virginia, Wisconsin, Wyoming, Iowa and Utah.

ried out prior to 1912 or more than eleven years ago. Most of the determinations were performed by investigators more than twenty years ago. These facts are pointed out at this point, since they have considerable to do with the emphasis which should be placed upon such findings, because of the improvements in methods of differentiation of pathogenic organisms during the last decade or two. The long periods of survival noted above may also be questioned when it is found that more recent experimental evidence shows that the life of such organisms as the typhoid fever bacillus, under the unsatisfactory influences usually found in digesting sludge, is well below those indicated by some of the earlier investigators.

In order to shed additional light upon the important question of the fate of bacterial life in sewage sludge, several experimental studies were made in our own laboratory, under the direction of Dr. R. C. Salter, upon samples of sewage sludge which were obtained from the Baltimore sewage disposal plant. The results of these studies are presented in Table V. The important findings noted in Table V are those which are concerned with the persistence of typhoid fever bacilli in various proportions of sewage sludge after different intervals of time. It is clear from these figures that, in a sewage sludge free to undergo normal digestion, the survival of typhoid fever bacilli is probably less in extent than seven days. This period of survival is apparently so much shorter than that found in a number of the earlier investigations, that it was thought desirable to make a search of the more recent literature in order to determine whether confirmatory data on this time interval are available. It will be evident from the conclusions indicated below that the accuracy of this short period of survival is amply supported by other independent investigators of recent date.

In 1921 Dr. I. J. Kligler of the Rockefeller Institute of Medical Research, issued a monograph on "The Investigation on Soil Pollution and the Relation of the Various Types of Privies to the Spread of Intestinal Infections." In the experimental work which Dr. Kligler performed in connection with his studies, he accumulated certain data which are of special interest. A number of experiments by Dr. Kligler are concerned with an attempt to answer the following questions: What happens to the pathogenic bacilli in sewage material which is undergoing decomposition and to those bacilli which, surviving such action, are then placed on the soil. Dr. Kligler's summarized conclusions are reported here as confirmatory foundations of the fact that the period of survival of pathogenic bacilli in sewage under the conditions herein discussed is a matter of days and not of weeks or months. Dr. Kligler concludes, at various points in his monograph, as follows:

It would appear, then, from these experiments that the Gram-negative bacilli of the typhoid-dysentery group die out rapidly in septic material. The typhoid bacillus may survive for about five days, the Flexner type of dysentery about three days, while the Shiga bacillus succumbs most rapidly. If the alkalinity of the fluid is low, in other words, if the tank is not "ripe," the organisms may survive for a much longer period. The germicidal power of the effluent from a ripe tank is probably due both to the alkaline reaction and to the presence of the antagonistic products of metabolism (p. 21).

It would seem that the speed with which typhoid and dysentery bacilli die off in soil would depend on a number of factors. Chief among these are the moisture content and reaction of the soil. The nature and abundance of other flora might play a secondary part. The important fact is that in dry or acid (moist or dry) soils most of the pathogenic bacteria would die off within ten days (p. 29).

As additional evidence for the validity of these findings, confirmatory of our own meager data, I am appending herewith tests, shown in Table VI, by additional independent investigators, Dr. Courmont and Dr. Rochaix, in Paris, who carried out their experiments during 1922. The results of the investigations of these two sanitarians in France are that the typhoid-paratyphoid group disappears in two to three days in aerated or non-aerated sewage, but in the same sewage *sterilized* they survive much longer. Under the same conditions, cholera-vibrio are not recovered after about six hours. These data give ample evidence of the fact that the distribution of pathogenic types in a sewage medium is dependent upon the "vital concurrence" of other forms of saprophytic life. Since these latter forms abound in sewage sludge which is undergoing digestion, if it has not been previously subjected to sterilization, it is clear that the opportunities for survival of objectionable organisms in digesting sewage sludge are relatively slight.

Although there has been some evidence presented at various times in the literature regarding the growth and survival of tuberculosis bacilli in sewage, it has not been possible to verify in any detail the length of survival in sewage sludge because of the difficulties inherent in the isolation of these particular organisms. There is reason to suppose, however, that the tuberculosis bacillus may have perhaps a greater viability than the organisms already discussed above, but whether it is of sufficiently greater vitality to survive more than seven days digestion in sludge our data do not indicate conclusively. Owing to the long and painstaking laboratory technique necessary to provide a definite answer to this question, it has not been possible to pursue it to its ultimate solution. It is our intention, however, to resume this investigation with reference to tuberculosis bacilli when more time is available in the laboratories.

TABLE V—PRELIMINARY EXPERIMENTS ON BACK RIVER SLUDGE

1. Three samples of sludge were obtained from tanks at the Baltimore Sewage Disposal Plant in two litre glass bottles.
Total bacterial counts at 37 deg. C. on agar, on each, using A.P.H.A. methods gave the following figures:

Sample number and description	Colonies per c.c.
1 Digested sludge	350,000
2 Raw sludge-settling tanks	10,000
3 Semi-digested sludge	490,000

2. Examination of the samples for B. coli group organisms, made by inoculating various dilutions into lactose broth fermentation tubes gave the following results:

Sample	B. coli found in dilutions
1 Digested 2 Semi-digested 3 Raw	none found in dilutions of $\frac{1}{10{,}000}$ c.c. or above B. coli confirmed in $\frac{1}{100{,}000}$ c.c.

3. Direct smears were made of the material on eosin methylene blue plates, using a drop (approximately 0.2 c.c.) of the sludge. Very scanty growth was obtained. A few (2) organisms of the colon-typhoid group were isolated from plate No. 2. No B. coli-like colonies were observed on plate 1, and only one on plate 3. Several were seen on plate 2.
No typhoid or paratyphoid bacilli were isolated in direct smears from the sludge samples.
4. One c.c. quantities of each sludge sample were inoculated into 5 c.c. of peptone broth and inoculated five hours, after which the culture was streaked on eosin methylene-blue plates. Results similar to the direct smear method were obtained.
5. The 24-hr. growth of twelve agar slants, inoculated with B. typhosus, was emulsified in 0.85 per cent NaCl solution and diluted to a volume sufficient for the purposes in hand.
6. A total bacterial count of this suspension, made just previous to inoculation of the sludge, showed the presence of 451,000,000 viable bacilli per cubic centimeter.
7. Five 200-c.c. portions of each type of sludge were drawn off into bottles. Into each bottle of the three series, of five bottles each, were put 1,2,3,5, and 10 c.c. quantities, respectively, of the bacterial suspension described above. The materials were thoroughly mixed.
8. Loopfuls of the mixtures from each of the fifteen bottles were taken at intervals, the first being taken immediately after inoculation. The table below shows the results of attempts to isolate B. typhosus from these loopfuls. In the first two attempts, enormous numbers of the bacilli appeared in almost pure culture on eosin methylene-blue plates. But in subsequent trials the growth dwindled till it was almost as scanty as in the original smears mentioned in paragraph 3.

C.C. of Suspension	Typhoid Bacilli Recovered	After Intervals of					
Sludge No. 1	Immediately	1 day	2 days	3 days*	4 days	5 days	7 days
1	+	+	+	..	—	—	—
2	+	+	+	..	—	—	—
3	+	+	+	..	—	—	—
5	+	+	+	..	—	—	—
10	+	+	+	..	—	+	—
Sludge No. 2							
1	+	+	+	..	—	—	—
2	+	+	+	..	—	—	—
3	+	+	+	..	—	—	—
5	+	+	+	..	—	—	—
10	+	+	+	..	—	—	—
Sludge No. 3							
1	+	+	+	..	—	-	—
2	+	+	+	..	—	—	—
3	+	+	+	..	—	—	—
5	+	+	+	..	..	—	—
10	+	+	+	..	+	—	—
Date	6/8	6/9	6/10	6/11	6/12	6/13	6/15

* No trials, this day being Sunday.

In the same manner, it has not been possible for us to present any data which would indicate definitely the exact period of survival of various forms of helminths and protozoa, such as hookworm larvae. In an interview with Prof. Stiles, our attention was called to the fact that an appreciable number of human cases of protozoal intestinal infection is continually appearing in the city of Baltimore. The excreta of such persons probably reach the disposal plant in varying concentrations at different times. It would have been interesting to determine, by artificial inoculation, what the fate of hookworm larvae would be in the sludge digestion tanks. This is one phase of the problem which it was my understanding that Dr. Collinson would investigate. He informs me, however, that an opportunity for the development of this study has not yet appeared. The results

TABLE VI—RESEARCH ON BACTERIAL PURIFICATION OF SEWAGE

P. Courmont and A. Rochaix. *Revue d'Hygiene*, Vol. 44, No. 10, Oct., 1922

Period	24 hour			48 hour			3 days			4 days			5 days		
Experiments	T	A	B	T	A	B	T	A	B	T	A	B	T	A	B*
Raw Sewage Aerated															
1	—	—	—	..	..	..	..	..	..	..	..	..	..	..	..
2	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..
2	+	—	+	—	—	—	..	..	..	..	..	..	..	..	..
4	+	+	+	..	..	..	+	+	+	+	+	+	—	—	—
5	—	—	—	..	..	..	..	..	..	..	..	..	..	..	..
6	+	+	+	+	+	+	—	—	—	..	..	..	..	..	..
Raw Sewage Non-Aerated															
1	—	—	—	..	..	..	..	..	..	..	..	..	..	..	..
2	+	+	+	—	—	+	—	—	—	..	..	..	..	..	..
3	+	+	+	—	—	—	..	..	..	..	..	..	..	..	..
4	+	+	+	..	..	..	+	—	+	—	+	+	—	—	—
5	—	—	—	..	..	..	..	..	..	..	..	..	..	..	..
6	+	+	+	+	+	+	—	—	—	..	..	..	..	..	..
Sewage Sterilized and Aerated															
1	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..
2	+	+	+	+	+	+	..	..	..	..	..	..	..	..	..
3	+	+	+	+	+	+	..	..	..	..	..	..	..	..	..
4	+	+	+	..	..	..	+	+	+	+	+	+	+	+	+
5	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..
6	+	+	+	+	+	+	+	+	+	..	..	..	..	..	..
	6 hour			24 hour			48 hour			3 days			4 days		
Aerated Sewage + Activated Sludge															
1	+	+	+	+	+	+	+	+	—	—	—	—	..	..	..
2	+	+	+	+	+	+	—	—	—	..	..	..	..	..	..
3	+	+	+	+	+	+	+	+	+	+	+	—	—	—	—
4	+	+	+	—	—	—	..	..	..	..	..	..	..	..	..
Non-Aerated Sewage + Activated Sludge															
1	+	—	+	—	—	+	—	—	—	..	..	..	..	..	..
2	+	+	+	+	+	+	—	—	—	..	..	..	..	..	..
3	+	+	+	+	—	+	+	+	+	+	+	+	—	—	—
4	+	+	+	—	—	—	..	..	..	..	..	..	..	..	..
Sterilized + Aerated + Activated Sludge															
1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2	+	+	+	+	+	+	+	+	..	..	..	..	..	..	..
3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4	+	+	+	+	+	+	+	+	..	..	..	..	..	..	..

	Aerated Sewage	Non-Aerated Sewage	Sterilized + Aerated Sewage
1	Vibrio Cholera	Vibrio Cholera	Vibrio Cholera
2	negative at	negative at	positive at
3	end of 6 hr.	end of 6 hr.	end of 6 hr. and 14 days.

*T = Typhoid; A = Paratyphoid A; B = Paratyphoid B.

of such a study would be important not only in this city or state, but in vast areas where such intestinal infections place a heavy and dangerous burden upon existing methods of sewage and sludge disposal. The problem is of particular interest, since certain investigators have already indicated that the natural decomposition of sewage does not bring about the same destruction of helminth and protozoal ova as it does of pathogenic bacteria. Dr. Khalil, of the London School of Tropical Medicine in Cairo, Egypt, for example, has recently demonstrated that the eggs of Ankylostome and Ascaris are frequently recovered in the sludge of septic tanks in a dormant state, capable of normal development into an infective stage in the course of six or eight days. This same conclusion has been indicated in the recent report of the Hookworm Research Laboratory, 1921, in which it is stated that the living ova or larvae of hookworm were found in the effluents from 19 out of 56 septic tanks functioning in and around Calcutta, India. It would be advantageous to carry our studies further.

D. Conclusions—After reviewing the evidence collected in this study one may arrive at two conclusions depending upon which body of facts are assumed to be of prime importance. If we are to formulate regulations as to the use of wet sewage sludge for fertilizer upon the basis of existing practice in this and in other countries, it would be clear that such sewage material should be applied to such crops as are not to be eaten raw. If recent laboratory data, however, should be the controlling factor, in the determination of the principles of regulation, it is not so clear that the same rigidity of restrictions is necessary as appears in existing by-laws and regulations. The laboratory evidence of recent date would appear to indicate that, if sewage sludge is held in a sludge digestion tank for a period of not less than ten days, its application to the soil for fertilizer purposes might be carried out without detriment to the public health through the possible dissemination of vegetable-borne disease. If the city of Baltimore were to find it possible to set aside auxiliary digestion tanks in rotation, in which sludge might be stored for a minimum period of ten days, such sludge might be safely used for fertilizer.

E. Recommendations—In view of the data as to practice and experiment heretofore presented, it is recommended that the authorities of the city of Baltimore be permitted to use wet sewage sludge for fertilizer purposes under the following rules and regulations:

REGULATIONS GOVERNING THE DISPOSAL OF WET SLUDGE TO FARMERS FOR FERTILIZING PURPOSES AT BACK RIVER SEWAGE TREATMENT PLANT, BALTIMORE, MD.

1. Only such sludge shall be delivered to farmers as has been undergoing digestion for at least ten days.
2. The wet sludge shall be carted in vehicles that are watertight.
3. Sludge shall be used on ground only before crops are planted. It shall not be sprinkled over or brought in direct contact with growing vegetables.
4. A permanent record shall be kept by Baltimore city of all persons obtaining wet digested sludge, date, location of farm and quantity of sludge taken.
5. The city reserves the right to discontinue at any time the distribution of wet sludge to any farmer.
6. Any person found violating any of the above regulations shall not be allowed to take wet sludge from the disposal plant or to obtain it in any other manner.
7. During those periods that wet sludge is being removed by farmers, the city shall have such inspection of the farms where the sludge is used as to be assured that the above regulations are being enforced. The State Department of Health reserves the right to future review and change in the above regulations.
8. Every person taking wet sludge from the disposal plant shall be supplied with a written statement from the city authorities in which shall be incorporated Sections 1 to 6 of these regulations.
9. All records of wet digested sludge distributed shall be open at all times to the inspection of the proper authorities.

Acknowledgments—So many public authorities in this country and abroad have kindly furnished me with material dealing with their practice that it is not practicable to name all of them in this report. I wish to take this opportunity to acknowledge, however, their unusual courtesy in forwarding such data to me. The representatives of the Baltimore City Sewer Division have granted me co-operation in every direction.

Research in Fire-Resisting Materials

The greatly increased fire losses of the past two years have resulted in an insistent demand for more research work on fire-resisting materials. The Bureau already has developed a large amount of valuable information. It has demonstrated that columns can be protected with a wide range of materials at a very slightly increased cost. The work has been particularly valuable in that it has shown the minimum amount of protection which can be used to advantage, particularly in respect to the thickness of walls which will be resistant to a considerable range of fire exposures.

Structural Alterations in a Concrete Building

Steel Columns and Girders Inserted to Carry Wall Columns of Upper Floors Over Widened Space in Lower Floors

By S. E. Berkenblit
Designing Engineer, Weary & Alford Co., Chicago

An example of structural possibilities in remodeling modern reinforced-concrete buildings is afforded by the recent construction of an addition to the Exchange National Bank Building at Tulsa, Okla. This 12-story building, at the southwest corner of Third St. and Boston Ave., was originally about 90 ft. square, and when built in 1916 it was not anticipated that extension to the south would be required. With the rapid growth of the city and of the business of the bank, however, it soon became evident that the building would have to be enlarged. Additional property was acquired on the west side in 1918 and the buildings on it were remodeled. But this extension proved inadequate and a new building program was decided upon in 1922, when adjacent property 75x140 ft. was secured on the south side.

The old building, known as unit No. 1, is in general of reinforced-concrete construction, but in the third

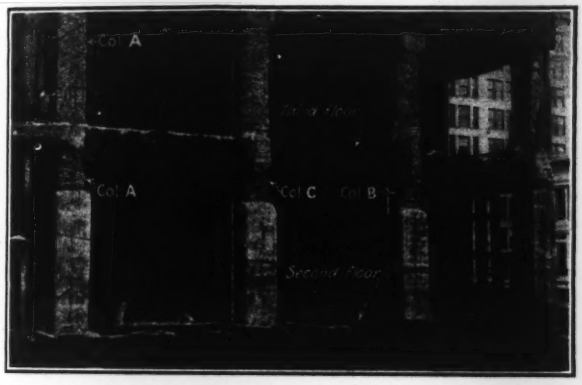


FIG. 1—REMOVING SECOND-STORY COLUMNS IN TWELVE-STORY BUILDING

Two concrete columns *A* and *B* replaced by steel columns carrying girder to support column *C* above third floor. Column *C* removed below third floor. Three upper columns ready for steel jackets transmitting their load to new steel supports.

floor there are heavy steel plate girders spanning the banking room or lobby and supporting an intermediate row of columns. These girders are carried by steel columns spaced 32 ft. c. to c. which rest on foundation piers under the basement floor. Some of the interior wall columns are also of steel from the basement to the third floor, for architectural reasons, but above the third floor the entire structure is of reinforced concrete.

In the design of the new south extension, or unit No. 2, it was necessary to provide for extending the 32-ft. banking lobby and to have its columns in the new portion the same size as those in the older portion. An obstacle to this arrangement was the massive construction of the old south wall, with three heavy concrete columns spaced 16 ft. c. to c. carrying spandrel beams at each floor and also a bank vault at the first floor. It was necessary, therefore, to remove the central column, from the first to the third floors; to replace the two side columns by more slender columns of steel, and to place on these new columns a steel girder at the third floor to carry the central or intermediate column in the upper floors.

A view of the work in progress is given in Fig. 1 and the general arrangement is shown in Figs. 2 and 3.

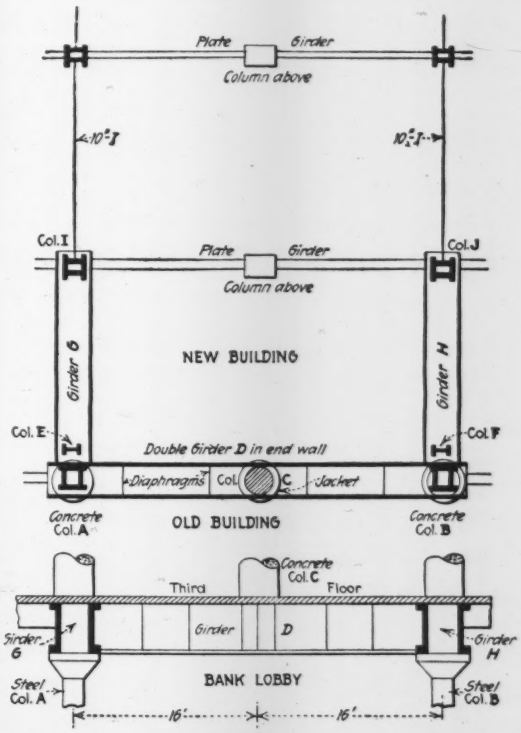


FIG. 2—DETAILS OF ALTERATIONS TO BANK BUILDING

In these drawings *A*, *B* and *C* are the columns to be removed, *A* and *B* being replaced by steel columns and *C* removed up to the third floor level; above that level it is supported by a double-web plate girder *D*, resting on the new steel columns *A* and *B*. Instead of the usual system of shoring, which was considered not well adapted to the design of this reinforced-concrete structure, it was decided to place jackets around the three columns, above the third floor, in order to carry the load on the third floor framing when the columns were cut away below that floor.

In the first place two temporary steel columns, *E* and *F*, were erected alongside the two outer columns, *A* and *B*, new foundation piers being provided for these temporary columns. This arrangement is shown by the drawings. Double-web 36-in. plate girders, *G* and *H*, were then placed, supported by the two temporary columns and the two building columns *I* and *J* in the new unit. At the north end these girders were cantilevered over the original columns *A* and *B*, and the double webs, 33 in. apart, straddled these columns. A third double-web plate girder, *D*, was then placed, with its inner 46-in. web framed between the cantilevered ends of the girders *G* and *H*, and its outer web extending across the ends of the cantilevers. These three girders form a part of the permanent framing of the third floor.

Steel jackets were then applied to columns *A*, *B* and *C* above the third floor. For the two outer columns

these jackets rested on the cantilever ends of the girders *G* and *H* while that for the middle column rested on girder *D*. In this way the superstructure loads on these three columns were transferred through the jackets to the three girders and the temporary columns, thus enabling the three concrete columns to be cut away below the third floor. As the next step, permanent steel columns were erected at *A* and *B*, under what had been the cantilever ends of girders *G* and *H*.

The old concrete columns, *A*, *B*, *C*, which were spirally reinforced and had a 32-in. core, were stripped of the concrete fireproofing for a depth of 9 ft. above and about 5 ft. below the third floor line. Each jacket was made 9 ft. high and consisted of four ½-in. steel curved plates having outstanding vertical lugs or flanges and making a 36-in. inside diameter when assembled. The lugs were reinforced with stiffener angles milled to a bearing on the plate girders below. Holes ⅞ in. in diameter and 12 in. c. to c., staggered both ways, were formed in the plates and flat bands 2½x½ in., spaced 12 in. c. to c. vertically, were riveted on the inside face of each jacket. The jacket of column *C* is shown in Fig. 4, with the bond bolts and spiral wrapping for the subsequent outer fireproofing of concrete.

After the jackets were put in place, surrounding the column cores, a rich mixture of concrete was poured inside and ¾-in. bolts were inserted in the holes as the concreting progressed. These bolts were of sufficient

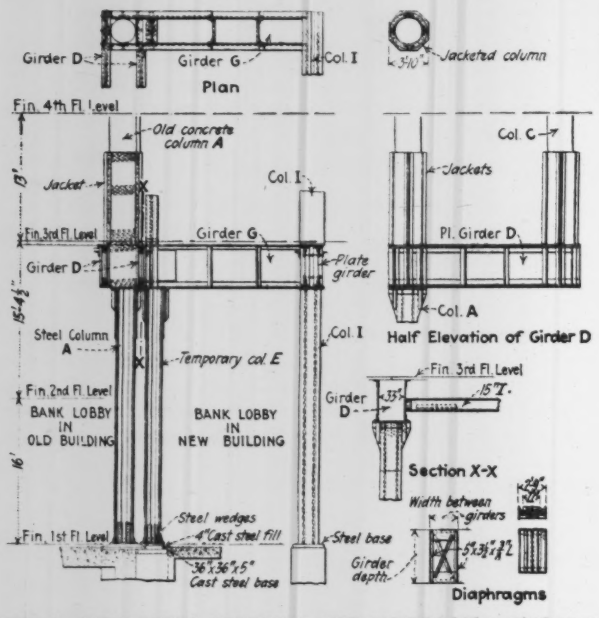


FIG. 3—NEW STEEL COLUMNS AND GIRDERS TO SUPPORT OLD CONCRETE SUPERSTRUCTURE

length to bond into the new concrete and into the fireproofing to be put on at a later date. This bond, together with the bearing on the successive ½-in. bands inside, was thought to be sufficient for securing the new concrete to the steel jackets. The bond between the new and old concrete of the column was made effective by undulations of the spirals and by the considerable hydraulic head developed during pouring due to the height of the jacket. This height also determined the unit bond developed between new and old concrete to be about 45 lb. per square inch, which was considered sufficiently low and safe.

A period of ninety days was allowed for the setting of concrete in the jackets before the actual work of transferring the loads through them was commenced. During this period a considerable portion of the new building unit No. 2 was erected and sufficient dead-load thus brought upon columns *I* and *J* to more than counterbalance the load on the cantilever ends of girders

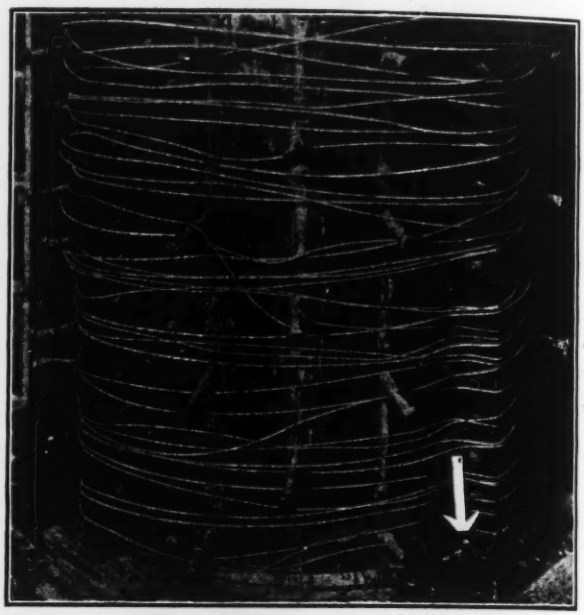


FIG. 4—STEEL JACKET ON CONCRETE COLUMN

G and *H*. At this stage steel wedges were driven between the outstanding lugs of the jackets and the tops of the girders and connecting diaphragms. These wedges were then permanently locked, after which the concrete columns at *A* and *B* were removed one at a time. The permanent steel columns in the same positions were subsequently placed underneath and tightly wedged against the projecting ends of the girders, which then ceased to be cantilevers. Finally the temporary columns *E* and *F* were removed.

An important feature of this operation was the creation of stress and deformation in plate girders *G*, *H* and *D* preliminary to removal of the columns. In order to avoid dangerous settlement in the concrete structure above when its weight would be brought upon the girders, it was essential to wedge these girders down an amount equivalent to deflection under actual load conditions before removal of columns. In doing this the transfer of load would not result in any sudden deflection and subsequent cracks in the structure.

This operation was simple in the case of girders *G* and *H*, due to the short length of the cantilever arms in relation to the depth of girders. No deflection was expected in this case, nor did any result when the columns underneath were removed. In the case of girder *D*, however, while the girder was made reasonably stiff, a deflection of ⅝ in. was expected under full dead and live-load on all floors. It was thought necessary, therefore, to wedge this girder down ½ in. to take care of at least the dead-load share of the total. This wedging was accomplished by simultaneous hammering of wedges under the jackets, one pair at a time, until the girder had been forced down the amount desired. The

jackets stood up perfectly well during this continuous hammering, which was taken as indicating that all conditions were satisfactory. Column *C* was then finally removed from beneath girder *D*.

As an additional safety factor, the stub end of the concrete column *C*, remaining between the webs of the girder and the diaphragms, was cut away sufficiently to allow placing six heavy 9-in. I-beams on the bottom flanges of the double-web girder, *D*, and the entire space was then filled with concrete. In this manner an actual bearing of the column on the girders was obtained.

A number of measurements were taken at different intervals to determine the behavior of the structure after removal of the columns, but no further deflection was disclosed and the work of construction was carried on to successful completion. A number of other structural difficulties were met at the various junctions between the old and new units, but they were successfully solved by judicious use of steel and concrete framing.

In spite of the difficulties in construction rapid progress was made. Excavating for new piers was started in August, 1922, and the building was ready for occupancy in July, 1923. The Weary & Alford Co., Chicago, was the designer of the building, with Gardner C. Coughlen as supervising architect, and J. Kenny Johnson, structural engineer. Hans von Unwerth, Kansas City, Mo., acted as consulting engineer for the owner. W. H. Horster, Tulsa, Okla., was the general contractor and erected the structural steel, which was furnished by the Kansas City Structural Steel Co., Kansas City, Mo.

Reconstruction Progress in France

RECONSTRUCTION work in France was brought much nearer completion in 1923, and the end of expenditures for this purpose is in sight, says a report to the Department of Commerce from Commercial Attaché Jones at Paris.

Up to Sept. 1, 1923, 2,861,000 decisions had been handed down on damage accounts, giving rise to claims amounting to about 62,000,000,000 francs. There remain to be settled 142,000 accounts which will probably involve payments of nearly 22,000,000,000 francs. The remaining claims, though only 5 per cent of the total number, involve amounts very much higher than the average and run to about one-fourth of the total amount of indemnities, which is about 85,000,000,000 francs.

The ten departments in the liberated region had at the time of the armistice only slightly over 2,000,000 inhabitants, these being those who had stayed in the devastated area to the end of the war. On Sept. 1, 1923, the number of inhabitants stood at 4,207,370, or about one-half million less than the prewar standard.

Of 22,900 factories destroyed or damaged at the time of the Armistice, 20,175 were restored by Sept. 1, 1923. Out of the 3,306,000 hectares of land made unsuitable for cultivation almost 3,000,000 hectares have been recovered, and of the 742,000 houses damaged or destroyed, 598,000 have been repaired or rebuilt.

Another reflection of the recovery which is going on in the ten devastated departments is given by the tax levies in the devastated regions, which have risen from 725,000,000 francs in 1913, the last prewar year, to 2,896,000,000 francs in 1922. The last figure is of course in paper francs, but even calculating these at their present gold value it appears that the devastated regions are paying the treasury more than in 1913.

Double Filtration of Water in Europe

Abstract of a paper by George W. Fuller, Consulting Engineer, New York City, read before a joint luncheon-meeting of New York Section, American Water Works Association, and the Sanitary Engineering Division, American Society of Civil Engineers, in New York City, Jan. 17.

THE DOUBLE filtration plant at Zurich is located on the lake of the same name several miles up the lake. Intercepting sewers extend two miles above the intake. The water from this lake is very clear, so that the purpose of the filter is "essentially for the removal of relatively large forms of vegetable and animal life designated as plankton," Mr. Fuller stated. The prefilters resemble somewhat the mechanical filters built in the United States. They operate at a rate of only 50 m.g.d., but without the use of a coagulant. Slow sand filters are operated at a nominal rate of 3 m.g.d. There is so little clogging that sometimes slow sand filters run 400 days or more between cleanings.

Filtration in Germany—At the Berlin plant (see *Engineering News-Record*, Sept. 13, 1923, p. 426), the prefilters operate at a rate of 170 m.g.d. and the final filters at a rate of 200 m.g.d. At Altoona, Germany, the waters now pass through mechanical filters of the Jewell type before going into the slow sand filters built many years ago and made world famous at the time of the cholera epidemic which ravaged Hamburg but scarcely affected Altoona. At Hamburg the use of a coagulant in water passing to large settling basins was discontinued during the war on account of cost. The water is now chlorinated. Prefilters and slow sand filters are used at Hamburg.

Filtration in Great Britain—Mechanical filters of 9 m.g.d. capacity (U. S. gallons) were authorized by the London Metropolitan Water Board in 1921 and are now in use. They treat River Thames water after it has passed through a reservoir holding about three weeks' supply and before this water goes to slow sand filters. Two generally similar mechanical filter plants are being built elsewhere by the London Metropolitan Water Board, having capacities of 21.6 and 38.4 m.g.d. respectively. Altogether Great Britain has "several dozen filter plants of the rapid sand or mechanical type, of which the more recent ones are quite generally similar to those found in this country," said Mr. Fuller. In most instances these serve for the preliminary treatment of water before it goes to slow sand filters in order to reduce the load on the latter. "There are some cases where coagulants are used," said Mr. Fuller, "but chiefly for removing deep vegetable stain from moorland waters. The cost of coagulants during the war and since has been so high that water-works men in Europe have given considerable attention to means of lessening or eliminating this item of cost."

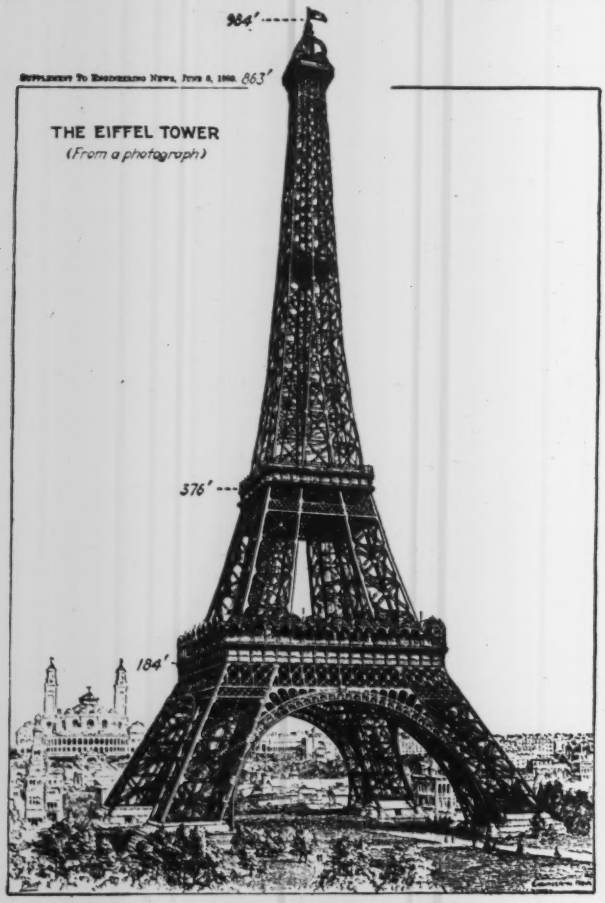
At Edinburgh there are both mechanical and slow sand filters. The color of the mountain water supplies is not as high as formerly and "an unusual effort is made to mix the water from several sources so as to secure a product which is of a moderate hardness, and in this mixing program the color of the unfiltered water is kept within the range which slow sand filters may reasonably treat. In consequence of this program and the desire to avoid the cost of coagulants, filter extensions at Edinburgh are being built of the slow sand type."

Finally, Mr. Fuller said in effect that European conservatism largely explains why water-works men there "lean so strongly to double filtration in instances where American practice would provide for plant extensions only a single filter of the rapid sand or mechanical type. The best general answer is that the Europeans, largely as a result of tradition, have to progress more slowly and are forced by public opinion to give great weight to precautionary arrangements which will protect the public health, even if it involves substantial expense at a period when water-works men abroad are put hard to it to secure funds with which to make betterments and extensions."

A. Gustave Eiffel

Life and Achievements of French Engineer Who Died December 28

ALEXANDER Gustave Eiffel, who died at Paris on Dec. 28, 1923, became world famous through the successful construction of a great iron and steel tower 984 ft. high for the Paris exposition in 1889. This tower, although the most conspicuous of his works, was not the most important from an engineering standpoint. It was but the culmination of years spent in the



SKETCH OF EIFFEL TOWER MADE IN 1889

building of metallic structures in which he demonstrated the practicability of his theories concerning the advantages of such structures over masonry for many purposes. He also was a pioneer in many of the methods of bridge erection which are now matters of common practice.

Mr. Eiffel was born in Dijon, France, in 1832, and was graduated from the École Centrale des Arts et Mètiers in 1855. He spent the first few years of his active life in the employ of one of the French railways and then in 1858 turned to the work to which he was to devote the greater part of his life. Among his most noted works are, in order of their sequence, the following: The foundations of the great railway bridge at Bordeaux, one of the early cases of the employment of compressed air; the bridge over the Nive at Bayonne, and two other bridges at Capdenac and at Floriac. In 1867 he was associated with Mr. Krautz in the construction of the large buildings of the Paris Exposition of that year; and in 1868, upon the lines of the Orleans Railway Co., he first adopted the system so consistently followed out by him afterwards of wrought-iron braced structures as a substitute for cast-iron columns or masonry piers. A little later, in 1869, he introduced with great success a system of launching bridges out on their piers after erection on the ground in the line of the bridge. The Sioule viaducts were the first attempt at putting this system into practice, followed by the viaduct at Vianna in Portugal, where iron girders were so launched into position. Then came the viaduct of Tardes near Montbucon, which was launched at a height of 328 ft. above the ground over piers 340 ft. apart. Mr. Eiffel was the first of the French engineers to erect bridges without falsework, by building out piece by piece; and his first work on this system was the erection of the 236-ft. span of the Cubzac bridge near Bordeaux. At Tan-an in Cochin, China, he erected in a similar way a bridge of 262-ft. span.

Of arch bridges built in the same manner as these just mentioned, his first great work was that over the Douro in Oporto, the central span of which is 534 ft., the rise of the arch 138 ft., and the height of the rail above the water 200 ft. But this was surpassed by his greater work at the Garabit viaduct, where an arch of 541 ft. crosses the Touyere torrent, 400 ft. above it. Among later great engineering undertakings carried out by Mr. Eiffel was the great train shed at Budapest, the Szegedin bridge, the principal façade of the Paris Exposition of 1878, and the dome of the observatory at Nice, which is 75 ft. in diameter, weighs 100 tons, and floats in a circular trough so that the slightest effort will move it. The framework of our own Statue of Liberty and the iron locks for the early French Panama Canal are examples of the work of this engineer in this continent. From the foregoing it is evident that Mr. Eiffel came to his latest task on the tower well trained by previous experience in works of really greater engineering importance and difficulty than the monumental structure at Paris.

The idea of a 1,000-ft. tower was not original with him. In 1833 Trevithick proposed such a tower in cast iron, and in 1874 David Reeves of Clark Reeves & Co. (later the Phoenix Bridge Co.) proposed such a tower for the centennial exposition at Philadelphia. In 1889 Mr. Eiffel speaking at a meeting in Paris, said, "The Eiffel tower was an American idea which came from a letter of David Reeves published in the *Scientific American* of January 24, 1874, in which he proposed for the centennial a tower 1,000 ft. high and 150 ft. in diameter on a circular base composed of 20 inclined Phoenix columns horizontally braced at intervals of 30 ft."

But the Eiffel tower as it stands is the outcome of a series of investigations undertaken by Mr. Eiffel in 1885 with a view of ascertaining the extreme limit to which the metallic piers of viaducts could be pushed with safety; his special line of investigation had reference to proposed piers 400 ft. high with a base of 140 ft. The idea of the tower followed, and the plans were worked out in connection with Messrs. Nouguier and Koechlin, two of Mr. Eiffel's principal engineers, and Mr. Sauvestre, the architect. The tower is essentially a pyramid composed of four great curved columns, independent of each other and connected only by a belt of girders at the different stories until the columns unite toward the top of the structure. Iron and steel were used throughout.

The base of the tower is a square with sides about 330 ft. each. The great arches in the base, which are merely ornamental, have a span of 243 ft. and a height to intrados of 129 ft. The maximum load upon the piers is 425 lb. per square inch, and the total load upon each of the two foundations away from the river is 1,970 tons. The top of the tower terminates 896 ft. above the ground in a platform 53 ft. square, though the width of the column at this point is 33 ft. only, the platform being extended on brackets. Above this platform rises the campanile, and above this is the lantern which crowns the tower and brings it to a height of 984 ft. The total weight of wrought and cast iron in this unique structure is 7,300 tons. It was formally opened to the public on March 31, 1889.

Mr. Eiffel's later days were clouded by the De Lesseps scandal on the Panama Canal in which he played a most reprehensible part.

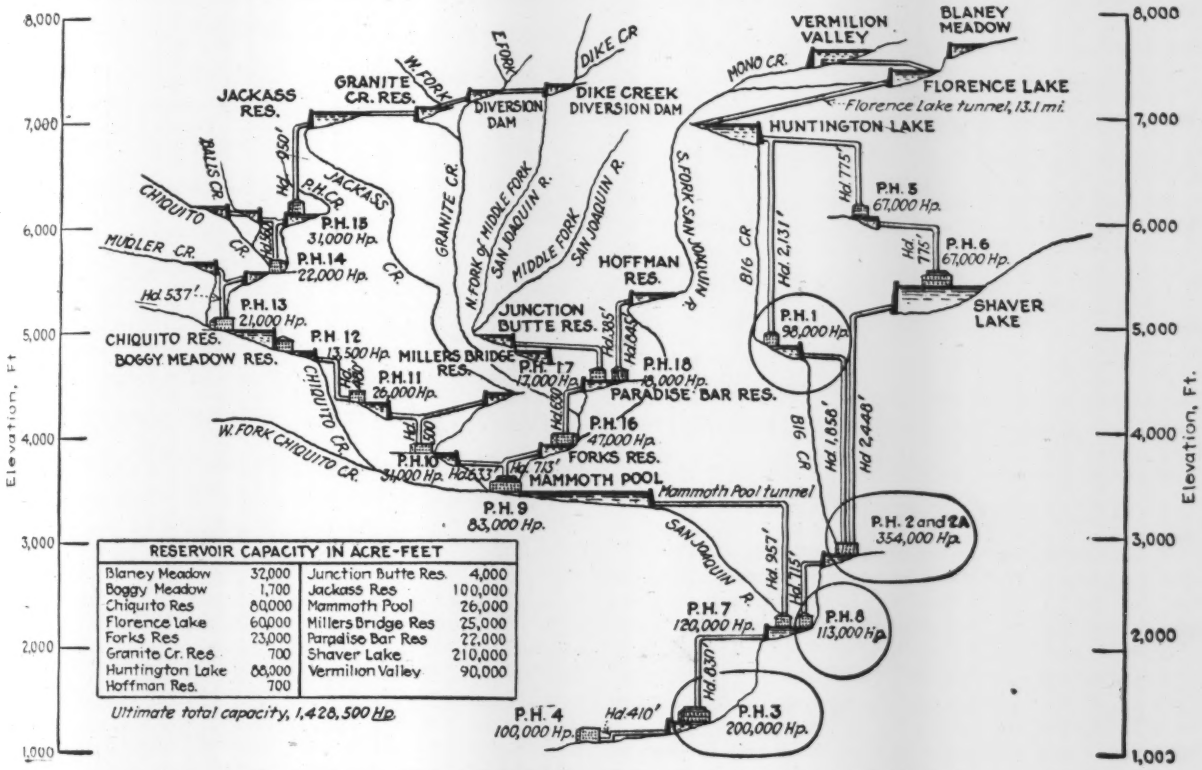
Drainage in Georgia and Tennessee

Drainage districts organized in Georgia during the three years 1920-1922 embrace more than 42,360 acres and contemplate an expenditure of $560,000, according to a statement issued by the division of agricultural engineering, U. S. Department of Agriculture. At the end of 1922 work had been completed for 8,199 acres and begun for 10,957 acres. Districts organized in Tennessee during the same period aggregated 36,078 acres and an estimated expenditure of $465,400. At the end of 1922, work had been commenced for 27,364 acres and completed for 2,964 acres. Drainage districts in Tennessee aggregated 445,955 acres on Jan. 1, 1920, while Georgia's districts then aggregated 104,000 acres.

Power Company Keeps Plan Decade Ahead of Developments

Program of Southern California Edison Co. for New San Joaquin Valley Power Units Mapped Out to 1935

THE hydro-electric development program of the Southern California Edison Co. is laid out for the next eleven years with power sites grouped in the same drainage basin whence transmission of electrical energy to load centers can be made with a minimum transmission-line expense. The accompanying schematic sketch shows the location of eighteen power houses on the Big Creek and San Joaquin River. Five of these have already been built and the remainder are scheduled for construction as the load demands require, present indications being that the series now laid out will be completely developed by 1935. The heads given are static in each case. Plants which have already been completed are indicated by circles. Tunneling methods in the long Florence Lake tunnel, which is well under way, were described in *Engineering News-Record*, May 3, 1923, p. 776.



RESERVOIR CAPACITY IN ACRE-FEET

Blaney Meadow	32,000	Junction Butte Res.	4,000
Boggy Meadow	1,700	Jackass Res	100,000
Chiquito Res	80,000	Mammoth Pool	26,000
Florence Lake	60,000	Millers Bridge Res	25,000
Forks Res	23,000	Paradise Bar Res	22,000
Granite Cr. Res	700	Shaver Lake	210,000
Huntington Lake	88,000	Vermilion Valley	90,000
Hoffman Res.	700		

Ultimate total capacity, 1,428,500 Hp.

GROUP OF POWER PLANTS ON BIG CREEK AND SAN JOAQUIN RIVER

Decision has just been reached to make the next addition to the total power available by adding units in two of the plants now in service. A new unit in power house No. 2 will require only the addition of a penstock, while the new unit proposed for power house No. 1 will require in addition to the penstock another flow line from Huntington Lake to the top of the power drop, a distance of about 2 miles. Work on these additions is to start early this spring.

Third-Rail Electrification for P. L. M. Ry. in France

Program Covers First 83-Mile Section on 1,860 Miles of Main Line—Also Local Lines and Paris Suburban Service

A THIRD-RAIL conductor for main-line electrification is an unusual feature in the system adopted by the Paris, Lyons & Mediterranean Ry., of France, for its 83-mile installation between Culoz and Modane, as the first section of a project for the electrification of 1,860 miles of main line. Continuous current of 1,500 volts will be used and is considered about the maximum practicable for the third-rail system, according to a paper by Marcel Japiot, chief engineer of rolling stock and equipment, in the *Revue Generale des Chemins de Fer*. Upon the results obtained will depend the adoption of the system for the entire electrification project.

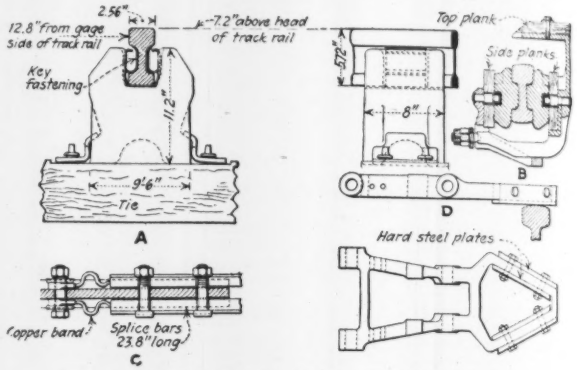
Advantages of the third-rail system as compared with the overhead wire system are said to be particularly in the simplicity of installation, supervision and maintenance. Interference with current on adjacent telephone and telegraph wires by the higher voltage of current used with the overhead system is cited as an objection to this latter system, making it necessary to carry these wires on separate posts at a distance from the track. It is stated by Mr. Japiot that although a low-tension current might be used with the overhead wires, the cost of such a system suitable for heavy grades and high speeds would be practically equal to that of a third-rail system.

Another advantage of the third-rail system is where both steam and electric locomotives are operated, as the overhead wire in such cases gets a sooty coating which prevents proper contact of the current collecting devices on the electric locomotives. In addition, gases from the steam locomotives cause corrosion of the overhead system, which results in heavy expense for repairs and renewals. Such corrosion is stated to have been experienced on the St. Gothard Ry. during the period of change from steam to electric traction. This feature is of importance on the Culoz-Modane line, since portions of it are included in two routes which will continue to be operated by steam.

The principal objection to the third rail is that it constitutes an element of danger to men working on the track. On the open line this difficulty can be minimized by placing both conductor rails in the space between the tracks and giving them a protective covering. But for yard tracks at large stations these rails would be too dangerous and for such cases an overhead wire is proposed. Furthermore, the third rail must be interrupted at switches and crossings, but these gaps should not be longer than the distance between the collectors on the locomotive, in order to insure uninterrupted delivery of current. To limit the gaps to this distance might require special and costly track appliances, which is another reason for eliminating the third rail at large stations. except for main tracks on which through trains travel without stopping.

A 100-lb. double-head rail section has been adopted for the third rail on the first 16-mile experimental section. This rail will be carried by insulators on long ties and will be secured in these supports by spring keys of bent steel plates. The rail splices will serve for both mechanical and electrical connection, short copper bonds being used to reduce the chance of theft. One end of each bond will be welded to the end of the steel splice bar and the other end bolted to the rail web. The type of bond for the joints of the track rails, to stand the shocks from heavily loaded wheels at high speeds, has not yet been determined. For protection the third rail is enclosed between two side planks and has a third plank above the top, these planks being attached to insulated supports, as shown.

Top-contact shoes on the engines will take current from the third rail. In ordinary weather these will have plain cast-iron contact plates and will be held upon the rail by springs. In winter, a special sleet-cutting shoe will be used, of a type used for some years on the



ELECTRIC TRACTION FOR FRENCH RAILWAY

A, Top-contact third-rail and supports. B, Plank protection of third-rail. C, Rail joint and bonds. D, Sleet-cutting contact shoe.

Chamonix line of this railway. This shoe, which is held down upon the rail by the piston of a compressed-air cylinder, has a triangular portion resting on the rail head and fitted with hard steel plates placed diagonally to the rail.

In the extensive electrification project of the Paris, Lyons & Mediterranean, two distinct types of service are included: (1) the Paris suburban lines, where the density of traffic is such that only electric traction can provide adequate accommodation; (2) the main lines in the district between Lyons and the south coast, which has vast water-power resources permitting a great saving to be made in cost of fuel. This latter part of the project involves the electrification of about 1,860 miles, but its completion is provided for a term of twenty years at least. As the first step, the company has selected two sections: (1) from Culoz to Modane, 83 miles, with heavy traffic and a combination of light and heavy grades; (2) the local lines near Nice, where a rapid, frequent and comfortable service by electric traction will develop traffic in this district of pleasure resorts.

For the Culoz-Modane section, the district has so many hydro-electric plants that it has been decided to purchase power rather than to build special plants for the railway service, especially as railway plants would have to be of ample capacity for a peak demand which would exist for only short periods. Current at 40,000 to 45,000 volts on the transmission lines will be converted to 1,500-volt continuous current at eight substations for the Culoz-Modane line.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

An Unsympathetic Tariff

Sir—The following experience might be of interest to readers of *Engineering News-Record*, particularly those doing work in foreign countries.

When working in Cuba last year, I had occasion to buy a computing machine for personal use. When I returned to the United States a few months later, I had to pay 40 per cent duty on this machine, though it was American made, sold to me by a representative of the American manufacturer for my personal use. Even though I plead that it was one of the tools of my trade I was compelled to pay the full duty, and broker's fees as well. This act covers any kodaks, portable typewriters, etc., bought by us abroad, as well as contractors' supplies bought on a temporary construction job abroad, and being American made.

L. N. SILER,
Stevens & Wood, Inc.

Youngstown, Ohio, Dec. 15, 1923.

Secretary Work and the Engineers

Sir—Have you noticed the campaign of intimidation that is being waged on the old employees of the U. S. Reclamation Service by the Secretary of the Interior? In the November-December, 1923, issue of the *Reclamation Record* appeared the following:

> The Reclamation Service must study footprints together with blueprints from now on. Blueprints have many abandoned monuments. Footprints mean people passing this way.

And in the January issue, page 1, this:

> The employees of reclamation are asked to study their service from a new viewpoint and, if possible, to fit themselves into it. Reclamation has been discredited. By whom or why is unimportant now, but the Service is its own advertisement and speaks for itself. A new future for it is being worked out by able men with painstaking care and results are the first concern.
>
> No one should deceive himself by thinking he is necessary to any position. There is no such thing as the "best man" or the "only man" for any position.
>
> The Reclamation Service will try to discover those who wish to remain with it, by appraising their attitude toward it. With a spirit of service demonstrated by disloyalty to the job any employee of the government becomes surplus and will be so regarded.

Then on the next page is a reprint of Elbert Hubbard's essay entitled: "Get Out or Get in Line. On page 4 in special typographic dress is "A Promise," quoted in part as follows:

> Many readers of the *Reclamation Record* have been living with hope abandoned, others with expectations deferred, but it is not too much to assure them that a new era of promise is here that gives assurance of being substantial and not conjectural.
>
> It is believed that costly experimental engineering has had its day and that "promoting" of reclamation primarily in the interest of construction will give way to that which will be practicable and profitable in operation.

On page 7 under the caption "A Settler Tells His Story" is reprinted the letter of Francis G. Tracy, President, Pecos Water Users' Association, which appeared recently in *Engineering News-Record*, the only one of all the articles published recently in *Engineering News-Record* that contain any disparaging statements in regard to the engineer management of the Reclamation Service.

Secretary Work is evidently making a studied effort to discredit engineering and engineers in general and reclamation engineers in particular.

He apparently is also carrying on an active campaign of intimidation against the present employees of the Service. Can it be that he is doing this with the idea of forcing the more important employees of the Service to resign? They may have to do it to save their self-respect if this propaganda continues. Then the coast will be clear for appointing more politicians in their places.

Effingham, Ill., Jan. 22, 1924.

E. A. MORITZ,
Consulting Engineer; Formerly Project Manager, U. S. Reclamation Service.

Engineering in Bridge Planning

Sir—In a recent editorial you stated that standard specifications for steel highway bridge superstructures would tend to make a trade of the profession of bridge engineering.

You say that no one would consider attempting to standardize arch dams or harbors. This would be impossible, because local conditions determine the decisions in each case. In the same way, local conditions around a bridge determine the waterway, location as affected by approaches and foundations, and the expenditure advisable to secure added esthetic appearance, as well as a number of minor points. The determination of an adequate, economical layout is of prime importance. Due provision for a desired traffic capacity is a secondary matter.

For a given traffic capacity, a span of a given length and type should have about the same design, be the location in New Jersey or Oregon, and rules leading to uniform designing may well be tabulated, since they will lead to economy combined with adequacy.

The specifications mentioned, therefore, deal with only that one phase of bridge designing independent of the location in view and do not touch on the primary considerations wherein the bridge engineer must exercise his judgment to fit a design to that given location and therefore will by no means make a trade of bridge engineering.

Denver, Colo., Dec. 28, 1923.

R. S. DUBOIS.

Ice Formation on Lakes

Sir—In the discussion relating to ice and swimming pools, *Engineering News-Record*, p. 1068 of the Dec. 27 issue, Mr. Hale did not mention all of the forces due to changes in temperature. On account of the small area of the average pool those forces may be thought negligible; still they are interesting, and in the Kansas pool they might be noticeable without close observation.

A rather intimate cold-weather acquaintance with one of the ponds or small lakes of which there are thousands scattered over the Northwestern states helps to a clear understanding. Usually these lakes are shallow and in severe weather they freeze over to a considerable depth, and the outer or shore parts of the area, frequently quite large, freeze to the earth. As the cold increases and the ice contracts, the entire surface cannot act as a unit or like a stove lid because the tensile strength of the ice is not sufficient to pull the outer fringe away from its frozen moorings and overcome resistance due to its own weight. As a result the ice itself gives way, often with a cannon-like report, and a crack of irregular location, sometimes with branches, has formed near the middle of the lake. The water from beneath fills the crack and quickly freezes, as there is no warm deep water for this emergency, the lake being shallow. Then as the temperature rises the ice sheet expands, its coefficient of expansion being about four times that of iron, and because the resistance of the ice to compression is five or six times its tensile strength the marginal ice is pushed shoreward.

Depending upon the rainfall the small lakes freeze over at different elevations in different years. Boulders are very common in that northern district, and nearly all in the lake bed are sooner or later pushed to the shore line and packed together with the frozen earth into a rude sort of ridge or wall that is responsible for the term "walled lake"

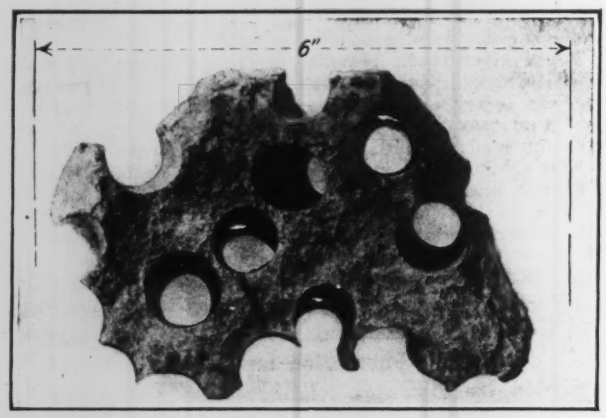
and "walled in by the mound builders." Where an abrupt drumlin forms the shore line for a little distance, the ice is pushed up the slope and broken into cakes, perhaps 2 ft. thick and several feet wide, and then pushed still farther until it is tipped at an angle of 60 deg. with the horizontal, forming a curious feature of the landscape. In the Arctic, precipitation and continued low temperature bring the glacier down and plow the sea bottom. In the Northwest, changes in temperature push rocks and earth further up on the land.

New York, Jan. 9. H. F. DUNHAM, Civil Engineer.

Stone Borers in Northern Waters

Sir—Herewith is a photograph of a piece of rock (an argillaceous limestone) showing the holes, presumably bored by *zirphaea crispata*, a rock-boring bivalve mollusc or clam, found in the coastal waters of the Atlantic seaboard of the provinces of Canada and a few other localities.

This specimen was dredged near the west side of the harbor of Sydney, Cape Breton, Nova Scotia (N. lat. 46° 11′ 10″, W. long. 60° 13′ 10″) from near the top (a few inches below the surface) of an approximately horizontal bed of rock about 10 ft. below low water of ordinary spring tides. It is 5½ x 3½ in. by about 1¼ in. thick and in it are nineteen complete or partial holes which would indicate



LIMESTONE, SYDNEY (N. S.) HARBOR, BORED BY CLAMS

that at this particular place there was a large colony of the borers. In the specimen the holes taper from 0.55 in. to 0.75 in. in the thickness of 1¼ in.

Evidence is not lacking that the borers, when very small (⅛ in. and less), enter the rock for purposes of domicile at the upper or smaller ends of the holes, taking their nourishment, like other molluscs, from the sea water that constantly circulates through their bodies, and that they live and die in their bores, because by their growth they effectually cut off their retreat.

I attach hereto a copy of an abstract from "The Economic Mollusca of Acadia." Also a copy of a report that I have just had from one of my assistant engineers, who with excellent powers and opportunities of observation, took an interest in the subject.

C. E. W. DODWELL, Supervising District Engineer, Maritime Provinces.

Halifax, N. S., Jan. 9, 1924.

Zirphaea Crispata (Linn.) Morch.
Zirphaea,—(?); Crispata, wrinkled.)
Date-fish.

Distribution. (a) General:—Shallow water to seventy fathoms. Connecticut to Gulf of St. Lawrence. Iceland. Northern Europe to Great Britain and France. West coast of America, South to California.

(b) *In Acadia:*—(In N. B.) Grand Manan, very rare, Stimpson, Bay of Fundy, eight to seventy fathoms, in hard clay, Verrill. L'Etang Harbor. (In N. S.) Sable Island, large specimens, Jones (on authority of Willis). Prince Edward Island, boring on red sandstone reefs, Dawson. Probably to be found in suitable localities all around our coast.

Habits. This is a well-marked shell and not like any other yet found on our coast. It is a bivalve, each valve of which is somewhat like that of the clam. Across the middle runs a furrow, in front of which the lines of growth rise in regular teeth, which are entirely wanting behind that line. The shell gapes very widely open both before and behind, and the dorsal margin in front of the furrow is folded over outwards. It does not exceed four inches in length in our waters, but grows much larger to the south and on the west coast. It is a burrowing mollusc, and lives in hard clay, soft stone or even submerged wood.

Economics. On the coast of California this species is extensively eaten. It is, however, much larger than with us, and is regularly exposed in the markets under the name of "Date-fish." It is not abundant enough in Acadia to be of any value. It appears to do no injury in its burrowing, to any of man's works.

From "The Economic Mollusca of Acadia," by W. F. Ganong. Reprinted from Bulletin No. VIII of the Natural History Society of New Brunswick.

Dear Sir:

During the summer of 1914 while on survey work on the shore of St. George's Bay, N. S., and about a mile from the mouth of Antigonish Harbor, I picked up a piece of soft rock (probably lime rock) in which were a number of round holes from ⅜ in. to ⅞ in. in diameter.

The piece of rock, which weighed about five pounds, was about 3 in. thick and contained nearly a dozen holes, some of which were clear through it. They were perfectly round and those that did not go through were rounded at the bottom and were much larger near the bottom than at the top. In one of the larger holes, which was just breaking through, I found a pair of shells (apparently of a species of clam) which had a row of teeth along the bottom edge of each half. Neither of these shells would come out of the hole they were in, which shows that the clams must grow while the boring is in progress.

Since finding the above specimen I have seen just two other pieces which showed the same borings, but contained no shells. One of these was at Little Bras D'Or and I was told by some fishermen that they often brought them up from the deep water off shore on the hooks of their cod trawls. The other piece was in ballast from the old wharf at Port Hood.

None of these pieces was in the position in which the boring had been done and I had never seen the live clam. However, during the past season while at Moucillier Passage between West Arichat and Lenox Passage I saw some fresh shells very much like the first ones I found, except that they were much thinner and had two or three rows of much smaller teeth along their bottom edges. After quite a hunt I found a great number of the live clams embedded in a large sod, of a peaty nature, which had recently been thrown up by a dredge from the side of the channel near a small island. This had evidently been part of a bog at one time as it contained a number of old spruce tree roots and stumps. The clams were all alive and were fully extended to between four and five times the length of their shells. The meat was almost white and I am sure would have been good to eat.

I have been told that the clams found in the submerged peat bog are the same as the ones found in the rock. If so, they have adapted themselves to circumstances and have not built their shells so thick or hard and have added a greater number of smaller teeth to their cutting edges.

W. S. ARCHIBALD, Junior Engineer.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

The Erie R.R. Co. Plans to Build new freight classification yards and engine terminals 9 miles east of Hammond, Ind., on its main line to Chicago.

Contracts for the Construction of three railroads in China are reported to have been signed by a British company. The total amount of the contract is about ninety million dollars.

Construction of 40 Miles of double track in southern California, some distance north of San Bernardino, is contemplated by the Atchison, Topeka & Santa Fe Railway. This will complete the double tracking between Los Angeles and New Mexico points.

A Study is Now Being Made by a special committee of the Special Libraries Association of the United States, pertaining to trade catalogs, and information is desired as to what firms in this country keep an historical collection of trade catalogs. Information regarding this subject would be gratefully received by Lewis A. Armistead, librarian, Boston Elevated Ry., 31 St. James Avenue, Room 711, Boston 17, Mass.

The President of the Canadian National Railways has issued an official statement showing an increase in net revenue for the year 1923 of $17,600,000. The operating revenue was $254,600,000, operating expenses $234,500,000 and the net revenue $20,100,000 as compared with a net revenue of $2,500,000 for 1922. These figures do not take into consideration any interest charges on the invested capital but come nearer to paying the interest than any year since the war.

Congress Has Been Asked by the City of Chicago in a formal resolution to direct the Chief of Engineers to make a survey of the commerce upon the Chicago and Calumet Rivers and in the port of Chicago and of the traffic across the rivers and in the streets of the city. This is done with the idea that the respective costs of movable and fixed bridges may be ascertained. It is requested that the Chief of Engineers report on the feasibility of the substitution of fixed for the movable bridges now required for these rivers.

From June 30 to July 12, 1924, are the final dates decided upon for the first world power conference to be held in connection with the British Empire Exhibition at Wembley, London. The conference is promoted in the council of the British Electrical & Allied Manufacturers Association. Co-operating with this council are many technical and scientific institutions and industrial organizations in Great Britain and other countries. C. C. Merrill, secretary of the Federal Power Commission, is general chairman of American participation in the conference.

Another Committee to Study Uses of Cement

A survey of the uses and properties of cement and concrete is to be undertaken by an advisory committee on cement which has been named by Commerce Secretary Hoover. In announcing the appointment of the committee the following statement was authorized:

"The cement industry has grown so rapidly and has achieved such great importance in the United States and the use of cement in the construction of roads, bridges and buildings has become so great and so diversified that the intelligent and appropriate use of this material becomes a matter of great economic interest to the public.

"Research work is now being carried on by the Bureau of Standards and by various public and private research laboratories and commercial and professional organizations in the properties, characteristics and proper use of cements in the improvement of methods, equipment and appliances tending toward improved efficiency and economy; the seasonal use of cement, especially in winter weather, important in its relation to continuity of employment of labor and the elimination of peaks and depressions and the spread of manufacture and distribution more evenly.

"It is proposed through the survey to co-relate for the benefit of the industry and the public the results of such scientific and technical activities and to center in and under the direction of the Department of Commerce a thorough and disinterested study of the entire subject. It is believed that such concentration of effort as the committee proposes to bring about will produce material results in the elimination of wasteful duplication of effort, and effect savings to the public and result in benefit to the manufacturer."

The committee is composed of the following members: John Lyle Harrington, chairman, consulting engineer, Kansas City, Mo.; C. H. Boynton, cement manufacturer, New York; N. Max Dunning, architect, Chicago; H. C. Turner, contractor, New York, and Charles M. Upham, highway engineer, Raleigh, N. C.

Commerce Commission Acts on Automatic Train Control

Supplementing its order of June 13, 1922, for the installation of automatic train control on one division of several railroads, the Interstate Commerce Commission, on Jan. 14, ordered similar installation on 92 more divisions, bringing the number of railroads affected up to 95 and the number of divisions to be provided with automatic train control up to 142. The new order specifies that the installations are to be made by Feb. 1, 1926, and requires that each road file complete plans and information as to the number of engines equipped with the signal device, on or before May 1, 1924, and to make a monthly progress report thereafter.

Court Holds Emerson Is Wyoming State Engineer

The Wyoming Supreme Court on Jan. 8, handed down a decision declaring Frank C. Emerson state engineer of Wyoming instead of Casper D. Shawver, who had occupied the position without pay since the removal of Mr. Emerson by Governor Ross almost a year ago, which removal has now been declared irregular.

Mr. Emerson was first made state engineer in 1919, being re-appointed by Governor Carey, April 4, 1921, for a six-year term. The 1923 state senate, the first following Mr. Emerson's appointment in 1921, endeavored several times to have Governor Ross send in Mr. Emerson's name for confirmation. This Governor Ross failed to do, and upon the last night of the session the senate obtained the commission of Mr. Emerson as executed by Governor Carey, and upon regular proceedings confirmed his appointment.

On March 13, about three weeks before the adjournment of the legislature, Mr. Emerson was served with a notice of summary dismissal by reason of "gross misconduct" and "flagrant breach of behavior" for allowing the senate to have his commission without the Governor's knowledge or consent. Mr. Emerson saw fit to contest his removal in the courts, and the State Supreme Court decision, but recently announced, is the outcome.

Mr. Shawver has been serving without pay pending the litigation.

Propose to Use Tidal Range for Power Development

An application for a permit to develop power by the use of the tides in the Bay of Fundy has been filed by Dexter P. Cooper, brother of Hugh L. Cooper, with the Federal Power Commission. This is the first application of this character to reach the Federal Power Commission. The project calls for the construction of five miles of dams, some of which will have to be built in water over 200 ft. deep. One dam will connect the mainland of Canada with Deer Island, a second Deer Island and Porto Bello Island, a third will extend across Lubeck Channel to the mainland of Maine, and still another will extend from the mainland to Deer Island. This latter dam will divide the inclosed water into two pools and will contain the power house where it is proposed to develop some 400,000 hp.

The upper pool will receive its water from the St. Croix River. It is equipped with gates which will be kept open until flood tide, when they will be closed and the lower pool allowed to empty until at ebb tide its gates also will be closed. The gates of the lower pool will be closed at ebb tide, thus maintaining the low level in this pool for considerable time. The total range in tides at this point is in excess of 30 ft. and Mr. Cooper calculates that they will be able to use a head varying from 16 ft. to 27 ft. and a flow of 200,000 sec.-ft.

Random Lines

Lunatic Engineering

Thirty odd years ago we remember looking with boyish condescension—than which there is none greater—at the full-sized multi-winged airplane Langley had hanging up in the rotunda of the National Museum at Washington. Not so many years ago we almost died laughing at the report that the army was going to give a prize to anyone who could fly thirty miles. So we aren't going to make fun of this professor who says he is going to shoot a rocket to the moon. But we will risk our scientific standing long enough to ask what in blazes is he going to do with it when it gets there.

Which also prompts an inquiry into this dirigible expedition the Navy is projecting over the North Pole. They must have more of these big gas ships and men to run them down in Washington than they have let the public know about. Or else there is some prospect of an arctic war which requires that we know how we are going to conduct an offensive campaign at 50 degrees below.

The Department of the Census has settled the question whether engineering is a profession or a trade in some statistics of births classified by occupation of the father. The grand average of children per father is 3.3. The obvious trades are higher; viz: mine foremen, 4.6; bootblacks, 3.9; stonecutters, 3.7. The obvious professions are low: e.g., physicians, 2.3; lawyers, 2.4; actors, 2.1; dentists, 2.0; chemists, 1.9. And the "technical engineers" are 2.1. Only the dentists and the chemists are more professional.

* * *

The Engineer in Public Life

The Commissioner of Public Works of the state of New York—an officer, an engineer and a litterateur—has been engaged in highly spectacular reform of his office and in spite of, or perhaps because of, his own authorial predilections he doesn't hold with the press. That same press now seems to be taking rather unnecessary space to describe in detail a bill to be introduced in the legislature conferring the rank of admiral on the Commissioner, creating a Barge Canal flagship for his use and specifying a resplendent uniform of vermilion and blue with a bearskin shako, side arms and short vamped rubber heeled dancing pumps.

* * *

Another One

"Youh workin' now, boy?"
"Yessuh. I's aquatic engineer."
"What youall mean, aquatic engineer?"
"Wy, I's in charge of de dish washin'."
—*Wampus.*

A. E. Lindau Becomes President of American Wire Fence Co.

A. E. Lindau, for the past nineteen years connected with the Corrugated Bar Co., Inc., has severed his connection with that company to become president of the American Wire Fence Co. of Chicago. Mr. Lindau has been vice-president of the Corrugated Bar Co. since 1921, having previously been general manager of sales. He joined that company in 1905, succeeding A. L. Johnson in 1906 as chief engineer, and upon the latter's departure for an extended stay in Europe, Mr. Lindau assumed responsibility for the development of the engineering department of the company as well as new products and methods of construction. In 1910 he redesigned the deformed bar marketed by the company and introduced the round deformed bar. A number of other products which he originated were exploited by his company during the past nineteen years.

Mr. Lindau, who is a graduate of the engineering department of the University of Michigan of the class of 1900, is the official nominee for president in the coming year of the American Concrete Institute. He is also a member of the Joint Committee on Concrete and Reinforced Concrete. Before becoming prominent in the reinforced-concrete field, he was in railroad work, leaving the position of assistant engineer in the bridge department of the Rock Island Ry. to go with the Corrugated Bar Co.

Bids Asked for River des Peres Improvements, St. Louis, Mo.

Bids for the first section of the River des Peres drainage works, for which bonds to the amount of $11,000,000 were authorized by the voters of St. Louis, Missouri, early in 1923, were received on Jan. 29. This job, known as Section A, will consist of a partly lined flood channel about 40 ft. wide at the base and 100 ft. wide at the top, and an underlying sanitary sewer semi-circular in shape about 8 ft. wide, both 5,600 ft. in length and together estimated to cost $350,000. It is expected that Section B, which will be of the same type of construction and about a mile in length, will be put under contract in the summer of the present year.

Steps are being taken for the condemnation of the easement for a strip of ground from 200 to 350 ft. wide and about ten miles in length, for the entire River des Peres improvement. A six-year program has been laid out for the improvement, involving about thirty contracts, including those for channel work, sanitary sewers and combined sewers, the latter up to 32 ft. in diameter, together also with a number of concrete bridges. The work is being done by the Board of Public Service, of which E. R. Kinsey is president, and W. E. Rolfe is associate. It is under the immediate direction of W. W. Horner, chief engineer of sewer and paving.

Wood-Preservers' Standards and Investigations

Treatment of Ties, Poles, Posts and Timbers—Use of Petroleum with Creosote and Zinc

Adoption of several standard specifications and consideration of the value of petroleum used in combination with both creosote and zinc chloride were important features of the twentieth annual meeting of the American Wood Preservers' Association, held at Kansas City, Mo., Jan. 15 to 17.

The new specifications for the treatment of ties, posts, poles and timbers provide that the preservative "shall permeate all of the sapwood and as much of the heartwood as practicable." Creosoted posts and poles must have not less than 10 or 6 lb. of oil per cubic foot of timber for the full-cell and empty-cell processes respectively. For creosoted ties and timbers the amounts are 10 and 5 lb. for the two processes respectively, but for timber in coastal waters a 16-lb. full-cell treatment is required. For ties and timber treated with zinc chloride, there must be not less than ½-lb. of dry salt per cubic foot of timber; when treated with a mixture of creosote and zinc-chloride, not less than 2 lb. of oil and ½-lb. of dry salt per cubic foot. Standards for methods of inspection of treated timber were also adopted.

Zinc-chloride received a good share of attention and it was suggested by H. Von Schrenk that this material is a more important preservative than has been generally recognized. An important paper by J. D. McLean, U. S. Forest Products Laboratory, discussed the relation of temperature and pressure to the penetration of wood by zinc-chloride solutions. Good service results of ties treated with zinc-chloride and crude oil were presented in a committee report.

That petroleum oil has advantages in protecting wood against checking and cracking, was stated in a committee report, but creosote-petroleum mixtures must contain sufficient creosote to prevent decay. Ties treated with petroleum and zinc-chloride will usually give better service than those treated with the zinc alone. The general value of tie treatment was brought out by a committee report giving the renewals per mile per year for a term of years on several railroads.

Officers for 1924 include: President, E. J. Stocking, Chicago; vice-presidents, S. D. Cooper, A. T. & S. F. Ry., and C. F. Ford, Rock Island lines; secretary and treasurer, P. R. Hicks, Chicago. The next meeting will be held at Chicago in January, 1925.

Two New Railroads Proposed for Province of Quebec

The Quebec legislature will be asked at its next session to incorporate the Quebec & Western Ry. with power to build a railway operated by steam, electricity, or other power, from Quebec via Chicoutimi and Mistassini to the mouth of the Nottaway River on James Bay. The legislature will also be asked to confirm the powers of the Quebec & Chibougamou Ry. and to extend the time for beginning and completing its proposed railway from Quebec to Chicoutimi and thence around Lake St. John and on to Lake Chibougamou.

Drainage Congress Dealt with Many Subjects

Drains, Levees, Flood Control—Oil-Engine Excavators—Engineers Elected Officers

Active co-operation of all drainage, irrigation and other reclamation organizations was advocated strongly at the twelfth annual meeting of the National Drainage Congress, held at St. Louis, Jan. 16 and 17. Engineers were well represented among the 126 delegates from all parts of the country and a majority of the papers dealt with engineering subjects. The drainage congress is an off-shoot of the Irrigation Congress and was formed by those who considered that reclamation of wet land by drainage has received inadequate attention, but it is not now proposed to again unite these two organizations. The policy of the present movement is that all the various organizations should retain their individualities and continue to work in their own fields and territories, but that there should be much closer co-operation, promoted by meetings of delegates from all these organizations.

A second high point was discussion of the relative merits of draining swamp lands for agricultural development or maintaining them for fish and game preserves. It was made clear that the Drainage Congress and drainage interests do not object to the preserves, provided that the rights of landowners are respected, but protest is made against indiscriminate action of sporting interests in creating objections to drainage where such reclamation is in the interests of the landowner and the public. Various remunerative uses for swamp lands, such as berry growing and the production of frogs and muskrats, were noted by John T. Stewart, civil engineer, St. Paul.

Land Reclamation

An extended review of land reclamation by the removal of excess water and the exclusion of flood waters was given by Jacob A. Harman, consulting engineer, Memphis, Tenn., the retiring president. That silt in drainage ditches and settling basins has its uses was suggested in a paper by R. N. Towl, civil engineer, Omaha. Extensive experimental studies of fluctuation in groundwater levels in this country and abroad were presented by Sven A. Norling, and drainage conditions in several states were discussed in a series of papers. There was considerable discussion on the replacement of open ditches by large tile drains. It was voted to appoint a committee to investigate the manufacture and use of clay and concrete drain tile.

Oil engines for dredges and other excavating machines were advocated, largely on account of fuel economy, at a joint meeting of the Drainage Congress and the Levee and Drainage Contractors Association, by George B. Massey, consulting engineer, Chicago. The engine may operate the several functions directly through belting and clutches, or it may operate an air-compressor or electric generator to supply power for these functions. Waterways were not overlooked. The low-water control of the Mississippi by wing dams and dikes was discussed by Charles Senour, U. S. assistant engineer, and the relation of levees to flood control by Captain E. H. Chisholm, secretary of the Mississippi River Commission, while the proposed Illinois waterway was the subject of a paper by W. G. Potter, drainage engineer of the State Division of Waterways.

Changes in the constitution were adopted to provide for a more permanent membership. The president for 1924 is Charles H. Young, consulting engineer, Muscatine, Iowa; vice-presidents, E. V. Willard, state engineer of drainage, St. Paul, Minn.; Roy N. Towl, consulting engneer, Omaha; H. J. Sternberg, drainage contractor, St. Louis, and L. L. Hidinger, president, Morgan Engineering Co., Memphis, Tenn. A new secretary was appointed, C. R. Thomas, Chicago, in place of James A. King, resigned, and the offices of the National Drainage Congress will now be moved from St. Louis to Chicago.

New President of Engineering Institute of Canada

Walter J. Francis

Large Building Program Urged for District of Columbia

Authorization of appropriation of $50,000,000 for the construction of buildings for the federal government in the District of Columbia, to be expended over a period of five to ten years, is recommended by the Public Buildings Commission in its annual report, submitted to Congress, Jan. 3.

The Commission, which has jurisdiction over most of the quarters of the government in Washington but has no authority over public buildings elsewhere, asserts in its report that new buildings are needed to reduce rentals, to protect adequately valuable records and to increase efficiency in work.

The Commission urgently recommends buildings to house the Bureau of Internal Revenue, the General Accounting Office, the Department of Agriculture, the Department of Justice and the General Supply Committee and that there should be an archives building.

In presenting the report to the House, Representative Langley of Kentucky, chairman of the House public buildings committee as well as a member of the commission, declared again in favor of an omnibus public buildings bill to care for construction throughout the country.

W. J. Francis Elected Head of Canadian Engineers

Montreal Consulting Engineer Who Has Been Active in Affairs of the Engineering Institute

Walter J. Francis, consulting engineer of Montreal, P. Q., who was elected president of the Engineering Institute of Canada on January 22, was born in Toronto, Ont. in 1872, attended the Ontario public schools and the Toronto Collegiate Institute and in 1893 was an honor graduate from the University of Toronto with the degree of C. E. After graduation he went into railway work and in 1898 entered the Department of Railways and Canals of Canada and was placed in charge of the design and construction of the lift-locks of the Trent canal. Later he was with the West Kootenay Power Co. on hydro-electric construction. In 1907 he was made assistant manager and chief engineer of the Dominion Engineering & Construction Co. of Montreal. He served as engineer for the royal commission of inquiry into the Quebec bridge disaster and since 1910 has been in private practice as a consulting engineer.

Last year he served as consulting engineer on a royal commission appointed by the Ontario government to report on the Hydro-Electric Power Commission of Ontario.

In March, 1923, following the death of Arthur St. Laurent, president of the Engineering Institute, Mr. Francis, then senior vice-president, was made president of the institute.

Mr. Francis is a member of the American Society of Civil Engineers; of the Institution of Civil Engineers of Great Britain, and a charter member of the American Institute of Consulting Engineers.

Greene Cuts Personnel and Costs in N. Y. Public Works Bureau

According to a letter recently received by Governor Smith's secretary from Col. Frederick Stuart Greene, superintendent of the New York Public Works Department, a gross annual saving of $271,681.15 will be effected through the reorganization plan which Colonel Greene has been working upon. So far 126 positions have been eliminated, those positions carrying salaries totaling $241,940.50 and six automobiles with an operating expense of approximately $15,000.

In the Bureau of Highways the positions of the secretary of the bureau, of two general maintenance inspectors, of the assistant to the first deputy, and of the third deputy and his entire staff have been abolished. The duties of the secretary of the bureau will now be performed by the assistant secretary, whose title will be changed to chief clerk. Division engineers aided by their sixty-nine county assistants will do the work of the two general maintenance inspectors whose positions have been abolished. The commissioner of highways and his first deputy will take over the duties of the assistant to the first deputy. Colonel Greene considers the Bureau of Town Roads, presided over by the third deputy and his staff, entirely unnecessary. The abolition of this office has been previously recommended.

Canadian Engineers Hold 38th Annual Convention

At the annual meeting of the Engineering Institute of Canada held in Ottawa, Jan. 23-24, 1924, Walter J. Francis was elected president and J. B. Challies, of Ottawa; F. P. Shearwood, and A. Surveyor, of Montreal, and F. A. Bowman, of Halifax, were elected vice-presidents. Major-Gen. Sir Alexander Bertram was elected treasurer and Fraser S. Keith, of Montreal, secretary.

The principal feature of the first day's program was an address by Dr. Charles Camsell, deputy minister of mines, dealing with the steps undertaken and the plans before the government for securing a domestic supply of fuel. He pointed out the necessity for Canada's making provision for the time when the supply of Pennsylvania anthracite coal will be no longer available. The most promising sources from which it is hoped to obtain substitutes are the Alberta coal, by-product coke, Welsh anthracite, and peat.

A very keen discussion took place at the Thursday morning meeting following the reading of a paper by D. W. McLachlan on the relative merits of the International Joint Commission's deep waterway scheme for developing the St. Lawrence River and the Ontario Hydro-Electric Commission's proposed development. He argued that ice formation between Morrisburg and the Long Sault Rapids would render the two-stage development as proposed by the Ontario Hydro-Electric Commission impracticable and that the single-stage development as proposed in the Bowden-Wooton report was much more desirable. F. A. Gaby and H. G. Acres, of the Ontario Hydro-Electric Commission, contended that the ice obstacle was by no means insuperable. At the close of the meeting the chairman announced that Mr. McLachlan's paper would be published and that opportunity for discussion would be given later.

At the noon luncheon on Thursday the centenary of the Rideau Canal was celebrated by an address from Hamnett P. Hill on the construction of the canal by Col. Bye and the Royal Sappers who were then stationed in Canada. In the afternoon the members visited the works of the British-American Nickel Corporation at Deschenes, Que.

Propose Another Extension of Reclamation Payments

Secretary of the Interior Work has recommended to the Senate Committee on Irrigation and Reclamation the passage of the bill of Senator Phipps (Colorado) authorizing extension of time on delinquent payments of reclamation settlers for another year. The extensions authorized in 1922 and 1923, each covering the preceding year, may thus be carried forward two years until the beginning of 1925; at the same time interest on the delinquent payments is fixed at 6 per cent instead of the present penalty rate of 1 per cent per month. Secretary Work claims that the bill is necessary to give relief to certain farmers who are in difficulties because the cost of many projects exceeds the amount originally estimated, farmers have not been able to market their crops, freight rates are high, and crops have failed.

New President of the Illinois Society of Engineers

E. E. R. Tratman, whose election as president of the Illinois Society of Engineers was announced in last week's issue, was born in Bristol, England. He began practice as an engineer in the office of a consulting engineer on railway matters in England, and in 1884 came to the United States where he was for a time with the Long Island R. R. and then in building practice. In 1886 he became an editor on the staff of *Engineering News*, specializing in railway work. In 1903 Mr. Tratman went to the Chicago office of *Engineering News* and, in 1917, became one of the western editors of *Engineering News-Record*. He is the author of "Railway Track and Track Work," a recognized standard work in the field.

Mr. Tratman is a charter member of the American Railway Engineering Association and a member of its committee on yards and terminals since its inception, an associate member of the American Society of Civil Engineers, member of the Institute of Mining Engineers, Western Society of Civil Engineers, Roadmasters Association, and the International Tramways Association. He served as secretary of the Illinois Society of Engineers from January, 1903, until his election to the presidency.

To Hold Preparedness Dinner

Co-operating with the War Department, the New York Section of the American Society of Civil Engineers, together with the New York sections of the other three founder societies and the Army Ordnance Association and the Society of Automotive Engineers, will hold on Feb. 5 an industrial preparedness dinner at the Hotel Commodore. The War Department has completed preparedness plans as provided in the National Defense Act of 1920 for industrial mobilization, but beyond that point it cannot go without the co-operation of manufacturers. It is the purpose of this dinner to bring to the manufacturers through the engineering profession the story of what has been done and tell them what further co-operation is necessary. Judge Elbert H. Gary will preside at the dinner. Dwight F. Davis, Assistant Secretary of War; Gen. John J. Carty, vice-president, American Telephone & Telegraph Co.; and Col. James L. Walsh, chief of the New York ordnance district, will be the principal speakers. J. H. Edwards, chairman, and William Barclay Parsons, J. Vipond Davies, J. Waldo Smith, and John P. Hogan, comprise the committee from the civil engineers.

New Home of Drainage Congress

The headquarters of the National Drainage Congress have been moved from St. Louis, Mo., to Chicago, where the new office is at 1163 Monadnock Block, in charge of C. R. Thomas, recently appointed secretary of the National Drainage Congress.

Two Offers to Operate Nitrate Plant at Muscle Shoals

During the past week two separate offers have been made to produce fertilizer at Muscle Shoals in standard leases upon the Government Nitrate Plant No. 2. The first of these offers was made by the Union Carbide Company of New York and the other by an association of three public utility companies, the Tennessee Electric Power Company, the Memphis Power & Light Company, and the Alabama Power Company. The offer of the utility companies followed a bid made by them a week previous for lease of the Muscle Shoals power properties owned by the United States Government.

The Union Carbide Company, if granted a lease of the nitrate plant 2 property, the Waco quarry and a yearly average of 50,000 hp., agrees to manufacture upward of 100,000 tons of fertilizing material of a nitrogen content of 20 per cent.

The bid of the utility companies contemplates the formation of a fertilizer company with a capital stock of $5,000,000 which will offer to lease nitrate plant No. 1 for 50 years and immediately begin construction of plants and equipment to produce a maximum of 50,000 tons of fixed nitrogen yearly. The actual product manufactured will include ammonium sulphate, ammonium phosphate or other nitrogenous concentrated fertilizer and also calcium arsenate to be offered farmers organizations and other consumers of fertilizer at 8 per cent profit on the actual cost of production. The proposal states 100,000 hp. made available at cost of production by the power companies offer will be used, as well as 40,000 additional horsepower when required for fertilizer production on terms to be fixed by the Federal Power Commission. Agreement is also made to maintain nitrate plant No. 2 in stand-by condition for the production of nitrates for munitions of war until Congress shall otherwise direct.

Founder Societies' Conference Committee Meeting

The first formal meeting of the Joint Conference Committee of the four Founder Engineering Societies was held January 21 in New York City where the Committee were guests at lunch of the American Institute of Electrical Engineers. It was decided at that meeting to ask the President and Secretary of the American Society of Civil Engineers to serve as Chairman and Secretary of the Committee for 1924. Hereafter the President and Secretary of the four Founder Societies will serve in order of seniority of Society. The subjects discussed were the World Power Conference in London in July, the plan of the Italian ambassador to bring recently graduated Italian engineers to this country, the proposed Pan-American Highway Congress to be held in this country next summer, the project of a National Museum of Engineering and Industry.

The four Secretaries were asked to present at the next meeting of the Committee a proposed policy for the co-operation of local sections in a community with one another and with the local engineering organization.

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting (20th anniversary), Chicago, Ill., Feb. 25-28, 1924.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Meeting, Chicago, March 11-13, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-24, 1924.

The Topeka (Kansas) Engineers' Club at its meeting held Dec. 19, elected the following officers for the year 1924: President, R. H. Pennartz, resident engineer, Shawnee Co.; first vice-president, W. S. Cammers, engineer, Atchison, Topeka & Santa Fe Ry.; second vice-president, C. A. Funchess, field engineer, Southwestern Bell Telephone Co.; treasurer, H. A. Marshall, consulting engineer; secretary, H. E. Buchanan, engineer with the Public Utility Commission; and member-at-large, F. W. Epps, Kansas Engineering Co.

The American Ceramic Society will hold its annual meeting Feb. 4 to 9 at the Hotel Traymore in Atlantic City. After Monday's general session, the seven industrial divisions of the society will hold special sessions for the reading of technical papers, and on the last three days of the week trips are planned to plants in New Jersey, eastern Pennsylvania, and Maryland.

Personal Notes

STANLEY A. KERR, recently made engineer on the Boise reclamation project in Idaho, has served in the reclamation work as junior engineer and assistant engineer, on various projects, then as project manager of the Fort Peck project in Montana, and most recently as engineer of the Flathead, Montana, project.

CHARLES J. POPELKA, formerly city engineer of Two Rivers, Wis., recently was appointed superintendent of streets in the public works department of Beloit, Wis.

RUSSELL L. WILLARD has returned from Paris, where he was engineer (assistant to the technical director) in the department of the Traitement Industriel des Residus Urbains, and has located at Urbana, Ill., as engineer for the Bates & Rogers Construction Co., of Chicago.

EDWARD R. KUPPER, civil engineer, of the Quartermasters Department, U. S. Army, who was superintendent of construction on Fort Benjamin Harrison in Indiana, is now superintendent of construction in the 8th Corps area at San Antonio, Texas.

WILLIAM G. B. THOMPSON, formerly chief engineer with the Bay Construction Co., St. Petersburg, Fla., has joined the force of the Raymond Concrete Pile Co., of New York City, as district representative.

L. J. SVERDRUP has been promoted to engineer of bridges for the Missouri State Highway Department, succeeding Chester D. Mann, who has entered private business in St. Louis.

CLARKE J. MADGETT has resigned as managing director of the London Bridge Co. at London, Ont., to take a position as contracting engineer with the Sarnia Bridge Co., at Sarnia, Ont.

A. LIEP, civil engineer, whose former service was with the water power service of the Dutch East Indies government, is now hydraulic designing engineer for the Electric Bond & Share Co., New York.

F. EARLE HARRISON, who for four years has been first assistant engineer in the city engineer's office at Schenectady, N. Y., has just been promoted to the rank of deputy city engineer. Mr. Harrison graduated from the Rensselaer Polytechnic Institute in the civil engineering course. He has served in the Syracuse Bureau of Engineering and for nearly three years was in the engineering department of the New York Central R.R.

H. D. SCHUTT has been appointed first assistant engineer in the Bureau of Engineering at Schenectady, N. Y., Mr. Schutt has had thirteen years' experience in design of reinforced-concrete and steel buildings and engineering structures and has served as superintendent of construction on several important works. For two years he was assistant engineer in the city engineer's office in Schenectady where he was employed upon construction of streets and schools. He is an engineering graduate of Union College.

HARRY L. DLYN, formerly chief draftsman of the Improvement and Construction Department of the American Car and Foundry Co., has been appointed chief engineer of Chanin Construction Co., Inc., 105 Court St., Brooklyn, New York.

GUY W. JOHNSTON has been appointed county engineer of Jack County, Texas, and will supervise highway construction for which over a million dollars was recently provided by a bond issue. Previously Mr. Johnston had been engineer in charge of state and federal aid projects in Hill County, Texas.

RALPH E. ROHN and WILLIAM H. HOFFMAN announce their association in the incorporation of the Structural Engineering Co., which will have offices in the new First National Bank Bldg., Canton, Ohio. The company will specialize in the design, fabrication and erection of steel structures of all types. Mr. Rohn recently severed a seven years' connection with the Canton Bridge Co., with which he served as chief engineer. Mr. Hoffman was employed by the Hughes-Keenan Co. of Mansfield, Ohio, as chief engineer. The new firm's field work will be supervised by Edward Adler, erection manager who has a record of thirty-two years with the Canton Bridge Co. as shop and erection superintendent.

Obituary

EDWARD F. VINCENT, Denver, Colo., formerly chief engineer for the Colorado & Southern R.R., and more recently special consulting engineer for the same railroad, died recently while on a visit to Jacksonville, Fla. Mr. Vincent was born in Maquoketa, Iowa, in 1863 and was a civil engineering graduate of the State University of Iowa. He entered the service of the Union Pacific in 1886 and from 1900 to 1903 was resident engineer of the Fort Worth & Denver City Railway Co. He was for a year assistant chief engineer of the Wyoming State Ry., now part of the Chicago & Northwestern, and for another year with the Missouri Pacific as engineer on surveys and later engineer of construction in the general office at St. Louis. In 1906 he was appointed assistant chief engineer of the Colorado & Southern and was later made chief engineer of the road.

GARWOOD FERRIS, civil engineer, builder of many early water-works, died Jan. 19 at Roselle, N. J. He was born in New York City in 1837 and was educated at Quackenbo's school there. He served in the Civil War in the Seventh Regiment. After the close of the war, he was one of the founders of the American Water & Gas Pipe Co., from which he later formed the firm of Ferris & Halladay, contractors. Ferris & Halladay were the construction engineers on the water-works of Jersey City, N. J., Glens Falls, N. Y., Portland, Me., Concord, N. H., and Charlotte, N. C.

RALPH MAYER, head of the Department of Engineering and Drafting and secretary of the Faculty of Applied Science at Columbia University, died Jan. 23 at St. Luke's Hospital, New York City, of heart disease; he was 65 years old. Professor Mayer had been a member of the teaching staff of Columbia University ever since his graduation from the Columbia School of Mines, Engineering and Chemistry in 1879. His home was in Mount Vernon, N. Y.

M. E. FREEMAN, for many years a building contractor of Portland, Ore., died in that city Jan. 7 at the age of 75 years. Mr. Freeman had built many of Portland's school and public buildings as well as handling construction of buildings in other Oregon and Washington cities. He was for some time inspector of streets in Portland.

JAMES R. HAMMOND, construction engineer for thirteen years with Stone & Webster, Inc., of Boston, died Jan. 7 of pneumonia at his home in Cleveland, Ohio. At the time of his death he was district manager of the division of construction and engineering for Stone & Webster, Inc., and was in charge of the Cleveland office of that organization.

JAMES F. CLEARY died at his home at Medford, Mass., Jan. 20, of pneumonia. For the past twelve years he had been connected with the organization of Stone & Webster, Inc., of Boston, and at the time of his death was engineer in the Station Betterment Division.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

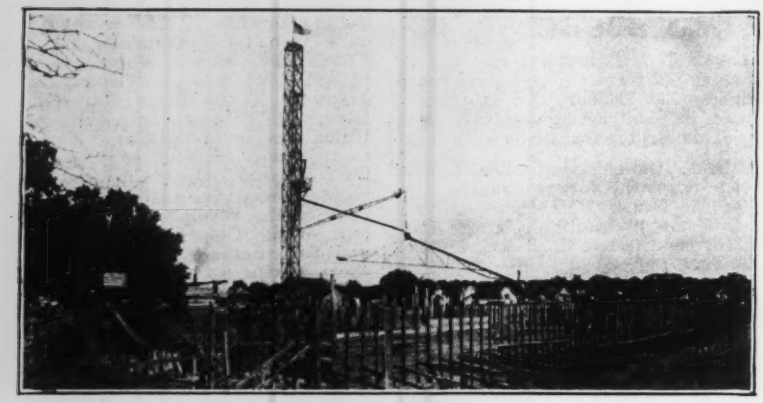


FIG. 1—TYPICAL STEEL TOWER INSTALLATION FOR SCHOOL-HOUSE CONSTRUCTION

Interviews with Industrial Executives—5

Obtaining Maximum Efficiency in Use of Concrete Chuting Equipment

Carl S. Wagner, vice-president of the Insley Manufacturing Co., Indianapolis, gives contractors and engineers the benefit of time-tried, practical suggestions on plant layout, erection, operation and dismantling.

WITH chuting equipment for the gravity distribution of concrete there are a great variety of ways in which manufacturers' standard units can be assembled to perform a certain work—with usually one *best* way. It follows, therefore, that perhaps the greatest single factor which enters into the successful operation of the plant is correct plant layout. Anticipated profits on concrete work have disappeared in more than one case through loading down a job with an arrangement of chuting ill-suited for the work to be performed and responsible for excessive handling costs. As a means of avoiding some of these construction pitfalls *Engineering News-Record* called upon Carl S. Wagner, vice-president of the Insley Manufacturing Co. for a practical discussion of layout and operation of gravity plant for the distribution of concrete.

"The Insley company believes," said Mr. Wagner, "that the greatest service it can render the men in the field is in making practical plant-layout recommendations. With this in mind the company has not only selected an exceptionally well qualified body of men to act as its sales representatives, but has reinforced them with a corps of engineers whose sole duty is to work on problems of the kind in question. These men, of practical as well as technical training, keep in close contact with actual work in the field, and as a result of their multiple experiences are enabled to serve as a sort of clearing house, passing on to each new project the experience gained on past works of similar character. The assistance of these men is at the disposal of any contractor who may have a job to equip."

While proper plant layout is of paramount importance, the real test of equipment comes in its operation. Operation, in turn, depends upon the proper erection of the plant. This offers a second opportunity for the manufacturer to be of service, and along this line Mr. Wagner offers the following suggestions applying to a typical steel-tower installation (Fig. 1):

Details of Installation

Receiving Equipment—The equipment, upon arrival, should be immediately checked against the detailed shipping lists furnished by the manufacturer and notations should be made covering any possible shortages which might delay erection. It is advisable that upon being unloaded from the cars all parts be placed convenient to the location of erection in order to eliminate unnecessary rehandling. Like parts should be piled together.

Tower Foundation—The tower foundation can be either of concrete (Fig. 2) or lumber made up of two layers of 2-in. plank laid in opposite directions (Fig. 3). The concrete foundation is recommended if the plant is to remain in place over a period of time when freezing and thawing might affect the ground, or when soil conditions are unsatisfactory. The foundation, whether of timber or concrete, should be of such dimensions as to provide 1 ft. or more of clearance all around the base of the tower for proper drainage and room to clean up spillage. Where a timber foundation is used lag-screws should be placed, as shown, to anchor the base of the tower and prevent lateral motion. Where a concrete foundation is used anchor-bolts should be buried in the concrete, as indicated.

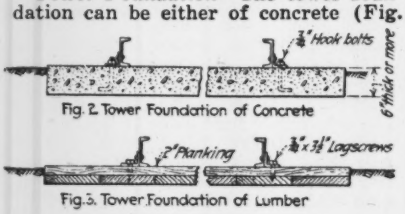


Fig. 2. Tower Foundation of Concrete

Fig. 3. Tower Foundation of Lumber

Drainage of the tower base is important. It should be away from the tower foundation and mixer whenever possible, and so arranged that the water does not undermine either the tower or mixer foundations.

Erection Rigging—Several types of gin poles are suitable for tower erection (Fig. 4). Two essential features are necessary; a length of 24 ft., and sufficient strength, without too much weight, to make handling easy. As a rule a 6x6-in. solid or laminated pole is heavy enough, but in case a solid stick is used care must be taken to select lumber free from knots, shakes and splits. This pole may be supported either by a 3x12-in. plank resting on the side horizontal struts, or by the corner gusset plates of the tower, as illustrated. In either case a ¾-in. pin is inserted in the lower end of the pole so that it projects about an inch at the bottom. A wrapping of wire should be put around the base of the pole to prevent splitting.

Another type of pole which has been successful is a ladder; it has three advantages: First, it is light and easy to handle; second, since it is broad at the base it requires fewer guys than would otherwise be required; and, third, due to its construction it is easier and somewhat less dangerous to climb when it is necessary to unhook the blocks from the corner members. This type of gin pole requires 2x8-in. vertical members. Various other types, such as gas-pipe poles, either straight or gooseneck, can be used at the discretion of the user. Gin poles with hog rods, however, should be avoided. It is unnecessary to go to any great expense in the securing of a suitable pole.

A hoisting engine with a niggerhead insures the greatest economy of erection. With it more work may be assembled on the ground and consequently heavier loads lifted with greater ease and speed. In case the tower hoist is not available it may be advisable to install temporarily a small builder's hoist.

Tower Erection—Having set the bottom frame, which is in one piece, and anchored it properly, the four bottom corner posts are set. The first sections of the tower are fitted up and bolted securely together, one set of diagonals and the bottom bucket guides on the front or rear being left out to permit the bucket to be swung into place. The erection of the tower proper is then carried forward to completion. The importance of placing the front and rear diaphragm plates correctly on the horizontal struts, Mr. Wagner points out.

cannot be overestimated. If these are bolted up tight as erection proceeds no wind in the tower will develop, and drifting of holes will be eliminated.

With the exception of the diaphragm plates it is not advisable to bolt the tower together solidly until after the guys have been put on and the tower pulled plumb. After the tower is plumb all bolts should be pulled up tight, care being taken to see that lock-washers are used on all bolts.

Guys—Guys are set every 40 ft., starting at the top. Fig. 5 shows a typical guy line using ¾-in. (6x19) C.C.S. wire rope or equivalent. A 1-in. turnbuckle with eyes and a 24-in. take-up, while not absolutely necessary, can be employed to advantage. This is joined to the deadman sling by means of a ¾-in. screw pin shackle, thimbles being used at this point and at the junction of the guy line to the turnbuckle. The value of having shackles installed in the lines occurs when it may be necessary to slip a guy during operation of the plant.

Erection Crew—The crew required to erect a typical steel tower plant is as follows:

1—Foreman.
3—Erectors—working on top placing members.
2—Erectors—on ground assembling members, sending up and laying out guys.
1—Hoisting engineer.

This crew should be able to erect and guy 80 ft. of tower per day.

Tower Attachments—The sliding frame, boom, counterweight chute and other parts which go to make up the complete plant are assembled either on the ground or as near ground level as may be possible. Manufacturer's erection drawings supply all the information needed for this operation.

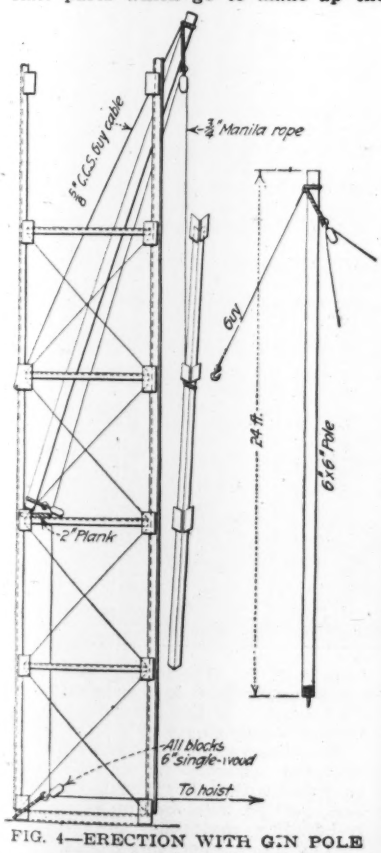


FIG. 4—ERECTION WITH GIN POLE

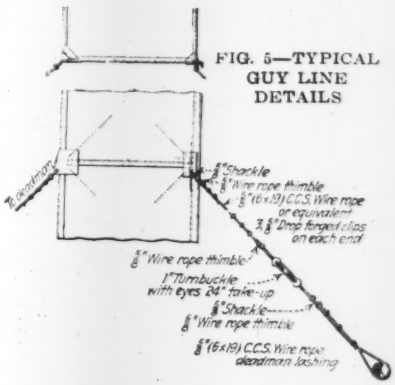

⅝" Shackle
⅝" Wire rope thimble
⅝" (6x19) C.C.S. Wire rope or equivalent
3 ⅝" Drop forged clips on each end
⅝" Wire rope thimble
1" Turnbuckle with eyes 24" take-up
⅝" Shackle
⅝" Wire rope thimble
⅝" (6x19) C.C.S. Wire rope deadman lashing

FIG. 5—TYPICAL GUY LINE DETAILS

Hints on Operation

After the plant has been properly erected its successful operation is largely dependent upon one factor quite apart from the concrete distributing plant as a mere assembly of equipment, and that is the manner in which the concrete is mixed. In spite of widespread publicity, to the contrary, there are still a great number of engineers and construction superintendents who think that concrete which is to be handled in chutes should be mixed with an excess amount of water. The concrete should be mixed so that the resultant mass is of a plastic, homogenous consistency, but it is better to have it too dry than too wet. If the concrete is properly mixed it can be handled in chutes with the complete elimination of clogging and the entire plant will function as a well regulated machine.

FIG. 6—ERECTION OF TOWER

Ordinary attention to the lubricating of the few moving parts, such as sheaves, bucket rollers, etc., is all that is required. It will be found to be of very considerable value to flush out the chutes with water when terminating a pour and to run two or three batches of grout through them when recommencing operations. It is also advisable to slush such parts of the tower as may be most liable to become covered with concrete with a heavy oil or grease, as this greatly facilitates the cleaning of the tower when it is dismantled. The front Z-bar legs which provide the support for the sliding frame should also be well lubricated with heavy grease in order to help the sliding frame move freely.

Dismantling—When dismantling the plant it is well to take the smaller members of the tower, such as the light angles that are used for horizontal and diagonal bracing, ladder bars, etc., and bundle these pieces, putting as many in a bundle as a man can conveniently carry. These parts should all be kept together and in the long run it will pay to brush the steel at the end of the job, give it a good coat of paint and see that the pieces are renumbered in accordance with the erection drawing. Pins, rollers, blocks and shackles should be carefully gone over and worn parts replaced. With ordinary care of this kind the tower will last indefinitely.

The chutes should all be examined and if they have become worn should be relined and given a good coat of paint. All grease cups, bolts, washers, pins and sheaves should be put away in a box so that none of the smaller parts will be lost during transportation of the plant to the yards and on to the job again.

It is well to roll all cables, such as guys, boom falls, bucket lines and shift line on reels, covering the cables with a heavy coat of grease and then wrapping the entire reel with old burlap or canvas. All cable-clips, shackles and turnbuckles should be oiled and carefully put away.

If the foregoing precautions are taken the tower and other plant parts will be found in perfect condition ready for immediate erection on the next operation and the contractor will be in possession of a truly permanent plant tool which can be counted on to function with equal efficiency on job after job.

Manufacturers' Section of A.G.C. Recommended

Functions of Proposed Body Would Include Standardization of Construction Equipment

Engineering News-Record Staff Report

Manufacturers of construction equipment, meeting with the executive board of the Associated General Contractors in Chicago, Jan. 18, requested the A.G.C. to form a manufacturers' division or standardization bureau, the function of which would be to establish equipment standards. It was the concensus of opinion of the manufacturers present that equipment standards could be determined and be accepted only through the medium of an impartial body such as the A.G.C. Past efforts at standardization by manufacturers themselves have been unsatisfactory, for there have always been certain interests which withdrew if their practices were not accepted.

The meeting was the outgrowth of the standardization efforts that have been under way under the auspices of the A.G.C. for the past year and a half. There was a feeling on the part of both manufacturers and contractors that more rapid progress was desirable and that it could be effected only through some permanent form of organization and the employment of some competent engineer or equipment specialist to direct the work. Some of the contractors suggested that the type of organization be broad enough so that, besides standardization, any problem might be brought up wherein the interests of manufacturers and equipment users touch.

The resolution expressing the view of the manufacturers, offered by Robert

C. Weller, of the Marsh-Capron Co., Chicago, requested the Associated General Contractors to form a suitable division to be conducted under A.G.C. auspices; that there be sub-divisions for consideration of different types of equipment; and that a set of requirements for membership be drawn up. Upon motion F. L. Cranford, the new president of the A.G.C., and Gen. R. C. Marshall, Jr., its general manager, were appointed a committee to draw up a plan and submit it to the manufacturers.

Thirty-seven manufacturing companies were represented including makers of the following types of equipment: Concrete mixers, contractors' cranes, power shovels, gasoline engines, wire rope, heavy cordage, earth-road machinery, locomotives, rock drills and compressors, hand shovels, motor trucks, tractors, trenching machines, electric equipment, derricks, hoists, belt conveyors, explosives, creosoting, paints, steel, lumber, and cement. C. E. Bement, president of Novo Engine Co., Lansing, Mich., presided.

Business Notes

P. J. DASEY, formerly with the Midwest Engine Corp. of Indianapolis as sales and research engineer has joined the Wellman-Seaver-Morgan Co., of Cleveland, as sales engineer in the engine division.

THE DORR CO., Engineers, Sanitary Engineering Department, established a branch in Chicago, Jan. 1. Frank Bachmann, heretofore a member of the New York staff, is in charge, and is located at the present office of the company, 38 South Dearborn St.

SCHUBERT-CHRISTY CONSTRUCTION & MACHINERY CO., Railway Exchange Building, St. Louis, has just been organized by Frank H. Schubert, formerly district manager of the Wheeler Condenser & Engineering Co., and William G. Christy, secretary of the St. Louis Section, American Society of Mechanical Engineers and formerly with the St. Louis Boat & Engineering Co. The new firm will represent manufacturers of power plant equipment.

WESTINGHOUSE ELECTRIC INTERNATIONAL CO. has announced the appointment of R. F. Hamilton as manager for the West Coast of South America; Mr. Hamilton, who succeeds R. A. Wrench, left for Santiago Jan. 5 to take up the duties of his new office. He spent the last four years in Madrid as consulting engineer to the Sociedad Espanola de Construccion Naval and its affiliated companies.

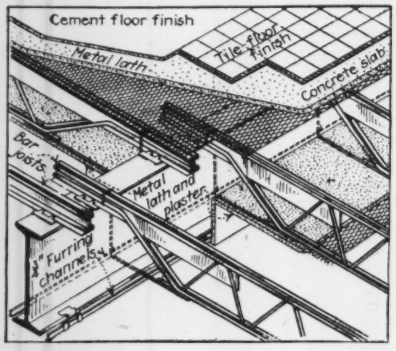
MERCURY MANUFACTURING CO., Chicago, announces the granting to Edmund Herbert Jahnz, of the agency for its tractors and trailers in Philadelphia and the territory tributary thereto, with offices at 2009 Market St., Philadelphia. Mr. Jahnz's experience includes three years with large motor truck companies and service as assistant electrical engineer at the U. S. Army Base at Charleston. He was later appointed general superintendent, in which position he had under his care all electrical transportation equipment including a large number of tractors. Since the war, Mr. Jahnz has represented the Lakewood Engineering Company, first in Virginia and later in Chicago.

THE AUSTIN-WESTERN ROAD MACHINERY CO., Chcago, announces that its Philadelphia branch office and warehouse has been removed from 2220 Market St. to 236 North 23rd St., where enlarged facilities for service on shipments and repairs have been provided.

Equipment and Materials

Steel Bar Joists for Fireproof Floor Construction

For fireproof floor construction in commercial, industrial and residential buildings the Massillon Steel Joist Co., Massillon, Ohio, has developed standardized steel structural units, in 18



sizes, known as bar joists. As shown in the accompanying illustration, each joist is built up of five steel bars formed and welded to the shape of a truss and provided with steel bearing plates at each end. Since the center line of the joists is below the line of bearing, the units, when placed, assume their correct position and eliminate the necessity of bracing. The use of these joists, the manufacturer claims, reduces the dead weight of floor slabs and, consequently, the weight of beams, columns and footings.

The 18 standard sizes of joist provided cover the ordinary range of loads and spans. Two standardized header sections meet the framing requirements for all small openings; large openings are framed in structural steel or concrete. All joists permit of variation of span of at least 1 ft. 6 in., thereby reducing the necessity of costly cutting.

In floor construction the ordinary practice is to use on top of the joists a concrete slab reinforced with rib lath. For ceiling construction the makers recommend the use of flat diamond mesh lath as the plaster base to be securely wired to the rod forming the lower chord of the joists.

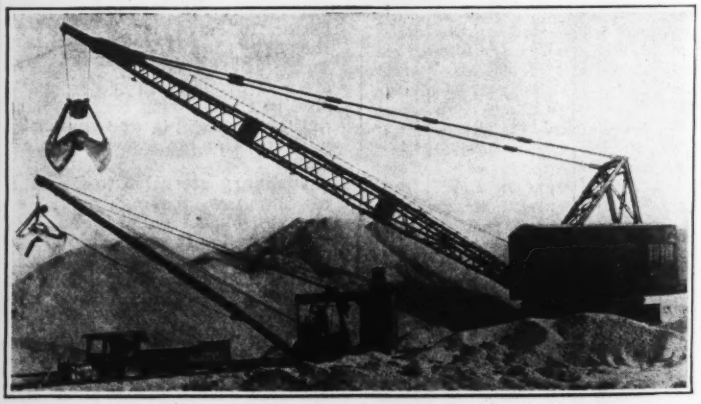
Drive Chains Strengthened

Nickel alloy steel has been adopted by the Chain Belt Co., Milwaukee, in manufacturing pins for chain drives for construction equipment such as draglines, locomotive cranes, power shovels and loaders. Test of the pins has indicated their value in reducing breakages and retaining proper pitch. The alloy pins are case hardened, giving a glasslike wearing surface approximately $\frac{1}{16}$ in. thick. The core of the pin, however, is unaffected by the case hardening process and retains the toughness necessary to resist shock and sudden heavy loads.

Crane With 90-Ft. Working Radius Handles 4-Yd. Clamshell

The Birmingham Sand & Gravel Co., Detroit, is confronted with the problem of unloading its cargoes of sand and gravel in minimum time, and of moving this material from the dock into the adjacent storage yard so that the dock may be cleared to care for the cargoes of other vessels. The accompanying illustration shows a large electrically operated traveling crane, developed and erected by the McMyler-Interstate Co., Cleveland, to handle materials at this plant with an unusual degree of rapidity.

This crane has a working radius of 90 ft. and handles a clamshell bucket having a capacity of 4 cu.yd. Under normal conditions, the crane makes at least two trips a minute swinging to an angle of 105 deg. and return. The hoisting speed, maximum load, is 200 ft. per minute. The machine is designed to travel on a track of 20-ft. gage, either straight or with curves, with 90-ft. minimum radius. The wheel



base is 21 ft. The arrangement of the operating mechanism is such that any or all functions of the crane may be performed either singly or simultaneously.

The illustration also shows a steam-operated convertible crawler crane, equipped with a 40-ft. boom and a two-line, 3-cu.yd. clamshell bucket, used for re-handling materials, as well as for loading into hoppers and trucks.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Business Outlook To-Day Compared With Year Ago

Business conditions at the close of 1923 are compared with conditions one year ago, in the accompanying tabulation. Cost, as is well known, is higher —14 per cent above January 1, 1923, according to *Engineering News-Record's* Construction Cost Index Number. Except in the case of iron and steel, December production of the major materials was notably heavier in 1923.

Demand in general is below that of a year ago, as indicated by the 34 per cent drop in unfilled orders on the books of the United States Steel Corporation and a decline of 11 per cent in lumber shipments. Car loadings for the week ended Dec. 29 were 13 per cent under the corresponding period in 1922, denoting a smaller distribution of merchandise in general.

The unfilled tonnage, however, gained over 76,000 tons during December, denoting a slight acceleration in steel buying which bids fair to forestall any chance of price weakness. Current steel quotations are 25 per cent above a year ago. The gain in cement shipments also reflects a trend toward more extensive winter building programs.

Monthly totals of checks drawn on individual bank accounts during 1923, conformed exactly with the trend of the 1922 totals, but were higher each month excepting August, September and October. The December gain of $3,944,181,000 shows a decided increase in the discharge of financial obligations.

A slightly higher interest rate shows a healthy trend away from the danger zone of speculation and consequent inflation. With domestic financial conditions sound the most disturbing feature in the foreign situation is the recent depreciation of the franc. Current exchange rates are compared with a year ago in the following table:

BUSINESS SITUATION AT THE BEGINNING OF LAST YEAR AND THIS YEAR

	January 24 1923	January 24 1924	Per Cent Up or Down
COST			
Avg. common bldg. labor rate per hr. in U. S. (20 cities)	$0.47	$0.54	+15
Structural steel per 100 lb. Pittsburgh	2.00	2.50	+25
Cement per bbl., net, Chicago	2.05	2.20	+ 7
Pine, N. Y., per M.ft. b.m.	59.00	60.00	+ 2
General construction cost (E. N.-R. Index)	192	220	+15
DECEMBER PRODUCTION	1923	1922	
Pig iron, gross tons *per day* (Iron Age)	94,225	99,577	— 5
Steel ingots, gross tons, *Dec.* (A. I. & S.)	2,711,529	2,779,890	— 2
Cement, bbls., *Dec.* (Geological Survey)	9,997,000	8,671,000	+15
Lumber (Natl. Lumber Mfrs. Assn.)	786,252,190	707,427,588	+11
Burned brick on hand on Dec. 1 (C. B. M. A.)	334,381,000	238,858,000	+40
DECEMBER DEMAND			
Car loadings (Week ended Dec. 29) Amer. Ry. Assn.	615,431	704,224	—13
Unfilled steel tonnage (U. S. Steel Corp.)	4,445,339	6,745,703	—34
Cement shipments	6,408,000	4,858,000	+32
Lumber shipments	740,503,397	832,170,571	—11
Contracts awarded (E. N.-R.)			
Commercial bldgs. ($150,000 up)	$68,800,000	$69,606,000	— 1
Industrial bldg. ($40,000 up)	19,997,000	19,176,000	+ 4
Streets and roads ($25,000 up)	21,035,000	18,096,000	+17
FINANCIAL			
Debits to individual bank accounts, December (Fed. Reserve)	$42,448,051,000	$40,436,981,000	+ 5
Rate on time money	Jan. 19, 1924 4½%	Jan. 19, 1923 4½@4½%	+ 3
Foreign exchange — Sterling	Jan. 23, 1924 $4.21	Jan. 23, 1923 $4.65⅛	— 9
Franc	.0446½	.0647	—33
Lira	.0433	0.0477½	— 9

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for, in Construction News, pp. 57 to 70, are the following:

Office, Worcester, Mass., Lockwood-Green & Co., Boston, archts., $2,700,000.

Paving, Dallas, Tex., $1,000,000.

Schools, Philadelphia, Pa., Bd. of Educ. 2 schools, $500,000 each.

Canadian Construction in 1923 Slightly Under Preceding Year

The close of the 1923 building season in Canada has registered the fact that including production of materials, the construction of engineering projects is the second largest industry in the country, agriculture having first place. The year just ended has witnessed a maintenance of the volume and value of work accomplished in 1922 and a tendency toward the stabilization of building costs, greater productivity on the part of labor and a loosening of capital.

The figures for 1923 show total construction undertaken to a value of $314,254,300, as compared with $341,843,800 in 1922. Even in 1920, which was a year of feverish expansion and inflated costs, the monetary value of new construction was sixty millions less than last year. During 1923 there was a falling off of 11 per cent in residential building. During that period 18,392 homes costing $88,826,000 were built, compared with 21,054 homes costing $99,858,800 in 1922. The outstanding feature of 1923 was the maintenance of marked activity in engineering construction. Projects undertaken in this department were 34.9 per cent of the total, compared with 36.2 per cent in 1922. General engineering projects such as hydro-power developments, railroad construction, etc., called for an investment of $49,356,700. Road construction totaled $43,590,000; bridges, $6,384,300; dams and wharves $5,240,000; sewers and water mains, $4,578,500.

Business Briefs

Call money remains at 4 per cent, Jan. 28.

Time loans range from 4¾@4½ per cent.

Commercial paper rates 5@4¾ per cent.

Foreign exchange lower. Sterling, $4.23⅜; prev. week, $4.26⅜; years ago, $4.66⅜. Franc, $0.0457½; prev. week, $0.047½; year ago, $0.0653½. Lira, $0.0436; prev. week, $0.0448¾; year ago, $0.054.

Large Contracts Let During Week

Among the week's announcements of Contracts awarded in Construction News, pp. 57 to 70, are the following:

Assembly Plant, Memphis, Tenn., Ford Motor Co., to Blair Constr. Co.; steel work to Virginia Bridge & Iron Co. $1,250,000.

Light and Power Plant, Somerset, Mass., Montauk Electric Co. to Stone & Webster, Inc., Boston $5,750,000.

Hospital, Brooklyn, N. Y., Bikur-Cholim Hospital to Tenential Corp., $1,000,000.

Apartment, New York, N. Y., H. A. Lenzer by day labor, $1,000,000.

Hotel, Chicago, Ill., Chicago Hotel Co., to Starrett Bros., $5,000,000.

Construction (1922-23) as Related to Population of State Groups

The accompanying table is a comparison of the construction work of the United States for the years 1922 and 1923 based upon state groups and their population. The population and the percentages of the total of each group will be the same for both years, based upon the 1920 census. The average amount of construction per capita for the year 1922 was $15.60 compared with that of $20 for 1923.

The figures for the amount of construction work done in the United States are based upon the reports of *Engineering News-Record's* correspondents located in every state of the Union. The minimum costs observed in Construction News on each class of construction are as follows: Waterworks, $15,000; other public works, $25,000; industrial construction, $40,000; commercial buildings, $150,000.

The per cent of total columns for the two years compare very favorably with the exceptions of the gains made in the states immediately West of the Mississippi and Far West for 1923. The money value of awarded contracts for these sections for 1923 increased over the previous year for two reasons; the increase in general construction and the greater efficiency in covering this section as reported to Construction News.

(*See table on p. 220*)

Construction in State Groups (1922-23) as Related to Population—Per Capita Construction in Each Group

State Groups	Population	Per Cent of Total Population	Total 1922 Constr.	Per Capita 1922 Constr.	Per Cent of Total 1922 Constr.	Total 1923 Constr.	Per Capita 1923 Constr.	Per Cent of Total 1923 Constr.
New England	7,400,909	7	$123,578,900	$16.70	7.93	$99,127,000	$13.40	5
Middle Atlantic	24,371,379	23	515,850,278	21.17	33.13	487,972,000	20.02	26
Southern	22,571,853	21	178,149,589	7.89	11.44	204,964,000	9.09	11
Middle West	21,475,543	20	404,474,367	18.83	25.95	485,629,000	22.60	26
West of Miss.	23,031,234	22	193,540,140	8.40	12.43	342,886,000	14.89	18
Western	6,859,702	7	140,997,735	20.55	9.05	278,676,000	40.63	14
Total	$105,710,620	100	$1,556,591,009	$15.60 (avg.)	99.93	$1,899,254,000	$20.10 (avg.)	100

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Jan. 3; the next, on Feb. 7.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.64	$4.00	$4.40	$3.30	$3.55	$4.20	$3.60	$3.85	$4.25
Structural rivets, 100 lb.	4.40	4.75	4.90	3.75	4.00	5.30	5.00	4.05	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.54	3.50	3.38	3.20	3.45	3.85	3.65	4.25	4.00
Steel pipe, black, 2½ to 6 in. lap, discount	44%	53.2%	43%	47%	53–5%	36%	37.10@47.40%	—45%	47.43
Cast-iron pipe, 6 in. and over, ton	61.60@63.60	56.00	61.00	57.20@60.20	+61.50	67.00	+59.00	62.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	+2.20	2.42	2.84	2.61	2.90	2.25
Gravel, ¾ in., cu.yd.	2.00	2.00	2.00	2.00	1.85	1.90	2.15	1.50	1.50
Sand, cu.yd.	1.25	1.42	2.00	2.00	1.25@1.50	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.75	2.00	2.83	2.00	2.00	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	+61.00	+40.00	54.75	+57.50	—43.75@45.00	57.00	—36.00	—29.00	65.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.65	1.85	1.50	1.50	2.70	2.10	2.80	9.50
Common brick, delivered, 1,000	+23.65@25.85	12.00	11.60	11.00	16@18	12.00	15.50	15.00	16.50
Hollow building tile, 4x12x12, per block	Not used	.10	.11	.0724	.075	.065	.....	.11	.115
Hollow partition tile 4x12x12, per block	.1179	.10	.11	.....	.....	.065	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.95	.98	1.07	.94	1.01	1.10	1.03	1.15	1.38
Common Labor:									
Common labor, union, hour	.75	.30	.....	.....	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	....	.25	.30@.50	.82½	.40@.45	.35@.50	.50	.62½	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers (pick and shovel men) 75c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Ce-plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 97.08. Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3-in., $47.43; 6-in. $119.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Weekly Review of the Market

The most significant feature of the current market is the steadily increasing demand for steel. Pig-iron inquiries are also taking an upward turn. While certain of the other basic industries, such as textiles and leather, show little of the improvement anticipated at the beginning of the year, they are expected to gradually fall in line with the trend of iron and steel.

The slowing up in demand for yellow pine which was becoming apparent during December, has given place to a rather brisk market with prices stiffening on many items. Reports from the Chicago district show a rise of $2 per M. ft. during the week, in yellow pine timbers. The pine markets in New York and Atlanta have been steadily firming. This is not the usual situation for this time of the year; short mill stocks, holiday shut-downs and bad weather having all served to prevent a general softening of pine lumber prices.

The situation in Douglas fir is quite the reverse. Lack of cutting orders is reflected in a decline of $1.50 per M. ft. in fir timbers at Seattle yards; a drop of $1 in Minneapolis and a $2 reduction in San Francisco.

Common brick is now quoted at $20 @$22 per M. as against $20, wholesale, alongside dock, New York. Advances in cement are also reported in several western cities. The price rose 2c. in Cedar Rapids; 10c. in Chicago and 10c. per bbl. in Milwaukee, effective during the week of Jan. 22, 1924.

Thus the general upward trend in such basic materials as cement, brick and pine lumber is reflected in the current *E. N.-R.* Construction Cost Index Number of 219.70, compared with 217.90 as of Jan. 3, 1924.

The iron and steel situation in brief, follows: Basic pig iron showing increased demand, owing to higher scrap prices. Volume of steel buying slowly increasing. Steel bars continue at the $2.40 base, with shapes and plates at $2.50 per 100 lb., Pittsburgh. Some shading of prices, however, is reported in structurals; as low as $2.35 per 100 lb. having been quoted on exceptional tonnages. Tin plate business active; mills operating at 95 per cent of capacity.